Pin CRT User Manual

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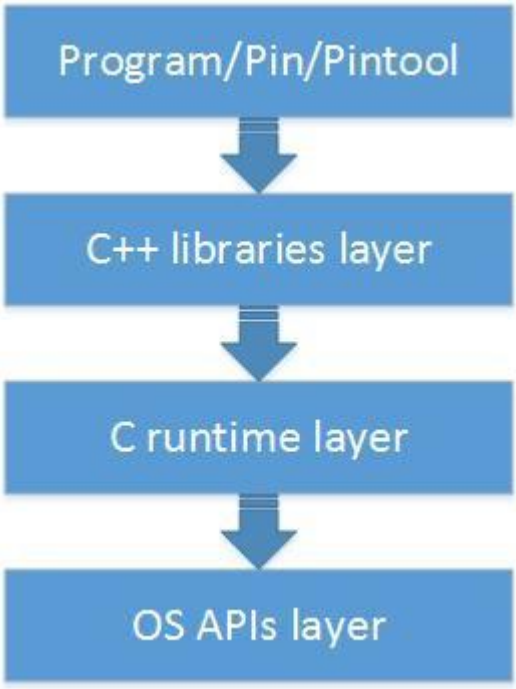
PinCRT overview

PinCRT architecture

PinCRT composed of 3 individual software layers, each of them depends on the previous layers:



- OS-APIs
    - Implements a common set of functions to interact with the operating systems.
    - Every supported operating system has its own OS-APIs implementation.

- C Runtime
    - Implements basic C functions like printf(), strcpy(), etc.
    - Provides process initialization/termination (e.g. calling C++ constructors).
    - Implements "Compiler runtime" – functions that explicitly instrumented by the compiler (e.g. 64 bit integer support on 32 bit architecture).
    - Provides a way to interact with the Pin loader.
    - Based on the implementation of libc for Android (bionic).

- C++ libraries
    - Implements C++ standard library functionality (e.g. STL).
    - Provides limited C++ runtime support:
        - Doesn't support exception handling.

        - Doesn't support operations that requires runtime type information (RTTI) - For example dynamic cast.
    - Based on LLVM 12 libc++ (Linux, Windows clang-cl kit) and STLPort implementation (Windows MSVC kit).

Technically, what is PinCRT?

- A set of headers that replace (mostly) the C runtime headers (e.g. stdio.h).
- A set of libraries (dynamic and/or static) that Pin tool can link with.

So, this means that in order to build a Pin tool with PinCRT we must:

- Compile the tool sources with PinCRT's headers (by replacing the include path).
- Link the tool object files with PinCRT's libraries (dynamically or statically).

Important note:

- Pin tool linked against PinCRT cannot be linked against any native system library (e.g. libc.so, msvcrt*.dll, etc.).
- There are several native system headers that can be included from a PinCRT enabled source file (see a list of them in "migrating from native CRT to PinCRT" section), but as a general rule you must not include any native system header when building for PinCRT (just use the PinCRT's replacements).

PinCRT features

- OS agnostic:

Provides the same interface (API) and the same behavior for C runtime on all platform.

- Compiler agnostic:

You can build your code with any compiler, then link it to the same binaries of PinCRT.

- Implements its own thread local storage

Doesn't share the thread local storage with glibc, MS-CRT, etc. This is a special requirement for binary instrumentation environment.

Supported operating systems

Currently PinCRT supports these operating system:

- Linux
- Windows

Build with PinCRT for Linux

Building with GCC

Compiler Parameters :

Macros:

- For all platforms: `-D__PIN__=1 -DPIN_CRT=1 -DTARGET_LINUX`
- For IA32: `-DTARGET_IA32 -DHOST_IA32`
- For Intel64: `-DTARGET_IA32E -DHOST_IA32E`

Flags:

- For all compilers :

```
-funwind-tables –fno-stack-protector -fasynchronous-unwind-tables
-fomit-frame-pointer -fno-strict-aliasing
```

- Only for **g++**: `-fno-exceptions -fno-rtti -fPic -faligned-new`

Include path:

```
-isystem $(PIN_ROOT)/extras/cxx/include \
-isystem $(PIN_ROOT)/extras/crt/include \
-isystem $(PIN_ROOT)/extras/crt/include/arch-$(BIONIC_ARCH) \
-isystem $(PIN_ROOT)/extras/crt/include/kernel/uapi \
-isystem $(PIN_ROOT)/extras/crt/include/kernel/uapi/asm-x86 \
-I$(PIN_ROOT)/source/include/pin \
-I$(PIN_ROOT)/source/include/pin/gen \
-I$(PIN_ROOT)/extras/components/include \
-I$(PIN_ROOT)/extras/xed-(XED_ARCH)/include/xed
```

Whereas:

```
BIONIC_ARCH is 'x86' for IA32, and 'x86_64' for Intel64
XED_ARCH is 'ia32' for IA32, and 'intel64' for Intel64
PIN_ROOT is the root directory of the Pin kit
```

Linker flags:

First of all, all dependent libraries from the linker command line, denoted by –l (small l) should be removed. These need to be replaced with their PinCRT counterparts.

Add these libraries to the linkage command line:

```
-nostdlib -lc-dynamic -lm-dynamic -lc++ -lc++abi -lpindwarf -ldwarf -
L$(PIN_ROOT)/$(TARGET)/runtime/pincrt
```

Whereas:

```
TARGET is 'ia32' for IA32, and 'intel64' for Intel64
PIN_ROOT is the root directory of the Pin kit
```

Build with PinCRT for Windows (MSVC Kit)

Instructions in this section are applicable for using the Pin Windows MSVC kit (pin-X.XX-buildnum-hash-**msvc**-windows.zip). Note this kit offers STLPort C++ runtime which supports C++03 standard only.

For Pin Windows LLVM-based kit (pin-X.XX-buildnum-hash-**clang**-windows.zip), which offers a modern C++11 compatible runtime library, kindly read Build with PinCRT for Windows (Clang-cl kit)

Building with Visual Studio

Compiler Parameters:

Macros:

- For all platforms: `/DPIN_CRT=1 /DTARGET_WINDOWS`
- For IA32: `/DTARGET_IA32 /D__i386__ /DHOST_IA32`
- For Intel64: `/DTARGET_IA32E /D__LP64__ /DHOST_IA32E`
- For building a PinTool or shared library: `/MD`
- For building an executable or stand-alone tool: `/MD`

Flags:

```
/GR- /GS- /EHs- /EHa- /FP:strict /Oi-
```

Include Path:

```
/I$(PIN_ROOT)/extras/stlport/include
/I$(PIN_ROOT)/extras
/I$(PIN_ROOT)/extras/libstdc++/include
/I$(PIN_ROOT)/extras/crt/include
/I$(PIN_ROOT)/extras/crt
/I$(PIN_ROOT)/extras/crt/include/arch-$(BIONIC_ARCH)
/I$(PIN_ROOT)/extras/crt/include/kernel/uapi
/I$(PIN_ROOT)/extras/crt/include/kernel/uapi/asm-x86
/I$(PIN_ROOT)/source/include/pin
/I$(PIN_ROOT)/source/include/pin/gen
/I$(PIN_ROOT)/extras/components/include
/I$(PIN_ROOT)/extras/xed-$(XED_ARCH)/include/xed
```

Whereas:

```
BIONIC_ARCH is 'x86' for IA32, and 'x86_64' for Intel64
XED_ARCH is 'ia32' for IA32, and 'intel64' for Intel64
PIN_ROOT is the root directory of the Pin kit
```

Additional include file:

You should add this switch to the compilation command line to include this file in every compilation:

```
/FIinclude/msvc_compat.h
```

Important:

If you're including Windows.h from one of you source files:

We provide our own replacement for this header file (since including Windows.h usually includes all MS-CRT stuff that we don't want to get). Our Windows.h replacement is actually a "wrapper" header for the original Windows.h that forces it to declare only the thing we wanted. In order to do so we must know where to find the original Windows.h file (located in Windows SDK). In that case, you'll need to add this to the compilation flags:

```
/D_WINDOWS_H_PATH_="$(ORIGINAL_WINDOWS_H_PATH)"
```

Linker flags:

First of all, Microsoft's libc libraries (e.g.: libcpmt.lib or libcmt.lib) should be removed from the linker command line. These need to be replaced with their PinCRT counterparts.

Add these import libraries to the linkage command line:

- For building a PinTool or shared library:
  `/NODEFAULTLIB pincrt.lib pinipc.lib kernel32.lib`

- For building an executable or stand-alone tool:
  `/NODEFAULTLIB pincrt.lib kernel32.lib`

Only dynamic PinCRT libraries are supported.

Libraries search path:

```
/LIBPATH:$(PIN_ROOT)/$(TARGET)/runtime/pincrt
/LIBPATH:$(PIN_ROOT)/$(TARGET)/lib-ext
```

Whereas:

```
TARGET is 'ia32' for IA32, and 'intel64' for Intel64
PIN_ROOT is the root directory of the Pin kit
```

Ignore linker warnings:

```
It is safe to ignore linker warnings #4210, and #4049.
Add these switches to the linker command line to suppress these
warnings:

/IGNORE:4210 /IGNORE:4049
```

Additional objects to link

For every libc, there is a static part that must be statically linked with all executables/shared objects. The exact object files to link depends on whether you build an executable or shared object.

For building a shared library or PinTool:

- This object file must be first in the linkage command:

```
crtbeginS.o
```

For building an executable or stand-alone tool:

- This object file must be first in the linkage command:

```
crtbegin.o
```

The above object files are located at

```
$(PIN_ROOT)/$(TARGET)/runtime/pincrt
```

Whereas:

```
TARGET is 'ia32' for IA32, and 'intel64' for Intel64
PIN_ROOT is the root directory of the Pin kit
```

Build with PinCRT for Windows (Clang-cl kit)

Introduction:

Pin provides a new modern LLVM-based C++ library that supports C++11 and replaces the old stlport-based C++ library which supports C++03 only.

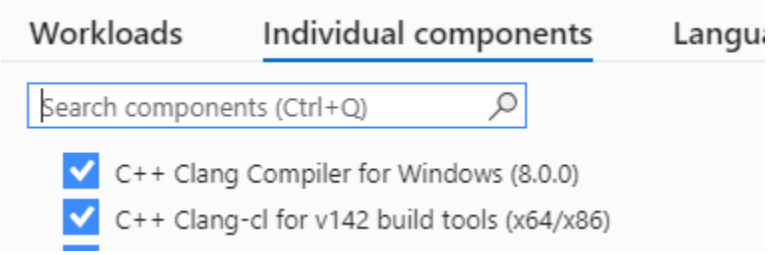
This library is now available on Windows OS as a separate PIN kit (pin-X.XX-buildnum-hash-**clang**-windows.zip) side by side with the legacy stlport-based kit (pin-X.XX-buildnum-hash-**msvc**-windows.zip)

Due to LLVM limitations, using/compiling the new C++ library requires Pin Tools to be built with the LLVM clang-cl toolset rather than Microsoft toolset. As Microsoft Visual Studio supports switching between the mentioned toolsets, adoption is mostly straight-forward. The below sections provide detailed instructions and steps to adopt and work with Pin Windows clang-cl kit.

Prerequisites:

Building Pin Tools with the LLVM C++ library requires Clang-cl version 14.0.5 as minimum (15.0.X or higher recommended)

If you have Visual 2022 installed, you can easily install clang-cl toolset by running the Visual Studio Installer and selecting the to install the following individual components:



See Microsoft documentation for full details.

After installation complete, verify clang-cl version by the following:
> "C:\Program Files\Microsoft Visual Studio\2022\Professional\VC\Tools\Llvm\bin\clang-cl.exe" –version

Alternatively, clang-cl for Windows can be downloaded directly from LLVM site

Building with Visual Studio

Important Note: Items marked in bold are unique to clang-cl. If you are migrating your code from MSVC to clang-cl, make sure these items are added to your compilation command line.

Compiler:

Make sure your build scripts/make files use LLVM clang-cl.exe and not Microsoft cl.exe

Compiler Parameters:

Macros:

- For all platforms:
  `/DPIN_CRT=1 /DTARGET_WINDOWS` **`/D_LIBCPP_DISABLE_AVAILABILITY /D_LIBCPP_NO_VCRUNTIME /D__BIONIC__`**
- For IA32: `/DTARGET_IA32` **`-m32`** `/D__i386__ /DHOST_IA32`
- For Intel64: `/DTARGET_IA32E` **`-m64`** `/D__LP64__ /DHOST_IA32E`
- For building a PinTool or shared library: `/MD`
- For building an executable or stand-alone tool: `/MD`

Flags:

`/GR- /GS- /EHs- /EHa- /FP:strict /Oi-` **`-Wno-non-c-typedef-for-linkage -Wno-microsoft-include -Wno-unicode`**

Include Path:

Include path should look like the following:

```
/I$(PIN_ROOT)/source/include/pin
/I$(PIN_ROOT)/source/include/pin/gen
/I$(PIN_ROOT)/extras/cxx/include
/I$(PIN_ROOT)/extras
/I$(PIN_ROOT)/extras/crt/include
/I$(PIN_ROOT)/extras/crt
/I$(PIN_ROOT)/extras/crt/include/arch-$(BIONIC_ARCH)
/I$(PIN_ROOT)/extras/crt/include/kernel/uapi
/I$(PIN_ROOT)/extras/crt/include/kernel/uapi/asm-x86
/I$(PIN_ROOT)/extras/components/include
/I$(PIN_ROOT)/extras/xed-$(XED_ARCH)/include/xed
```

Whereas:

```
BIONIC_ARCH is 'x86' for IA32, and 'x86_64' for Intel64
XED_ARCH is 'ia32' for IA32, and 'intel64' for Intel64
PIN_ROOT is the root directory of the Pin kit
```

Note: If you are migrating your code from MSVC to clang-cl, make sure to remove the following

from include path:

```
/I$(PIN_ROOT)/extras/stlport/include
/I$(PIN_ROOT)/extras/libstdc++/include
```

And replace with:

```
/I$(PIN_ROOT)/extras/cxx/include
```

Additional include file:

You should add this switch to the compilation command line to include this file in every compilation:

```
/FIinclude/msvc_compat.h
```

Important:

If you're including Windows.h from one of you source files:

We provide our own replacement for this header file (since including Windows.h usually includes all MS-CRT stuff that we don't want to get). Our Windows.h replacement is actually a "wrapper" header for the original Windows.h that forces it to declare only the thing we wanted. In order to do so we must know where to find the original Windows.h file (located in Windows SDK). In that case, you'll need to add this to the compilation flags:

```
/D_WINDOWS_H_PATH_="$(ORIGINAL_WINDOWS_H_PATH)"
```

Linker Parameters:

Linker flags:

First of all, Microsoft's libc libraries (e.g.: libcpmt.lib or libcmt.lib) should be removed from the linker command line. These need to be replaced with their PinCRT counterparts.

Add these import libraries to the linkage command line:

- For building a PinTool or shared library:
  /safeseh:no /NODEFAULTLIB pincrt.lib pinipc.lib **c++.lib** kernel32.lib
- For building an executable or stand-alone tool:
  /safeseh:no /NODEFAULTLIB pincrt.lib **c++.lib** kernel32.lib

Only dynamic PinCRT libraries are supported.

If you are migrating your code from MSVC to clang-cl:

1. Make sure the items in bold above are added to your linker command line.
2. Replace calls to Microsoft Linker (link.exe) with LLVM linker (lld-link.exe)

Libraries search path:

```
/LIBPATH:$(PIN_ROOT)/$(TARGET)/runtime/pincrt
/LIBPATH:$(PIN_ROOT)/$(TARGET)/lib
```

Whereas:

```
TARGET is 'ia32' for IA32, and 'intel64' for Intel64
PIN_ROOT is the root directory of the Pin kit
```

Ignore linker warnings:

```
It is safe to ignore linker warnings #4210, and #4049.
Add these switches to the linker command line to suppress these
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Additional objects to link

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- This object file must be first in the linkage command:

```
crtbeginS.o
```

For building an executable or stand-alone tool:

- This object file must be first in the linkage command:

```
crtbegin.o
```

The above object files are located at

```
$(PIN_ROOT)/$(TARGET)/runtime/pincrt
```

Whereas:

```
TARGET is 'ia32' for IA32, and 'intel64' for Intel64
PIN_ROOT is the root directory of the Pin kit
```

Using clang-cl with Pin - Known issues & BKM

Do not use fastcall convention with Analysis calls in 32-bit tools

There is an outstanding clang issue with fastcall calling convention and the use of large integers as function parameters in 32 bit tools. Do not use fastcall with analysis routines until this issue is resolved. The fix is planned for version 16 of clang.

clang casting issues

Casting with clang is not implicit, and it requires to explicitly declare it in your code. Specifically, clang does not cast automatically from (char *) to (void *) during function call. It issues a compilation error. To go around it, explicitly cast to (void *). This should happen with other pointer type castings as well.

clang Optimizations

Clang compiler has a more sophisticated optimization. so always disable it (/Od) to develop your code before and when you are done switch to /O3. If it fails, a good chance that it has to do with clang optimization going around.

Std::tr1 replaced by ::std

Some C++ classes (e.g. unordered_map, unordered_set, etc.) were under std::tr1 namespace in Stlport. Now they are under ::std itself. Fix your code accordingly.

Avoid warnings as errors

Clang by default is much stricter than Microsoft CL to warning, and by default treats them as errors. If your code is sensitive to that, disable these errors in advance by using a -Wno-<> corresponding directive.

Example:

```
-Wno-unknown-pragmas -Wno-pointer-sign -Wno-incompatible-pointer-types …
```

MMX and AVX Instrinsics handling (and intrinsic in general)

Clang-cl favors gcc flags conventions over Microsoft compiler ones.
Specifically when using MMX/AVX, this can result in cases where capabilities bundled with a single flag in Microsoft compiler need to be split to multiple gcc-style flags. Here are some examples:

/arch:AVX → -march=skylake-avx512
/arch:AVX → -mfma
/arch:AVX → -mxsavec -mavx
/arch:AVX → -maes -mpclmul -mssse3

clang-cl optimization impact on mxcsr register

clang-cl optimization might impact mxcsr and as a result cause inconsistent instruction ordering when using intrinsic.
For example, performing rounding routine after the following code might end with incorrect calculations:

```
__m128 ma   = _mm_load_ss(&af);
__m128 mb   = _mm_load_ss(&bf);
```

```
__m128 mres = _mm_mul_ss(ma, mb);
_mm_store_ss(&rf, mres);
```

To overcome this issue, declare the registers as volatile as shown in the following example:

```
volatile __m128 ma   = _mm_load_ss(&af);
volatile __m128 mb   = _mm_load_ss(&bf);
volatile __m128 mres = _mm_mul_ss(ma, mb);
_mm_store_ss(&rf, mres);
```

Clang-cl supports GCC's asm volatile convention, therefore another alternative is to provide your own linux-style assembly definition of this intrinsic:

```
__asm__ __volatile__("movss      %1, %%xmm1      \n\t" // xmm1 = af
                     "movss      %2, %%xmm2      \n\t" // xmm2 = bf
                     "mulss      %%xmm2, %%xmm1  \n\t" // xmm1(af) *= xmm2(bf)
                     "movss      %%xmm1, %0      \n\t" // store result in rf
                     : "=m"(rf)                       // Outputs
                     : "m"(af), "m"(bf)               // Inputs
                     : "%xmm1", "%xmm2"               // Modifies
```

Note the above enables you to write better cross-compiler code

Migrating from native CRT to PinCRT

Get rid of OS-specific functions calls

As a general rule, PinCRT supports only ISO C functions.
So, in general, no OS-specific functions are implemented in PinCRT (although there are some implementation of OS-specific function for some functions we chose).

Make sure you're using the correct header files

When building a Pin tool with PinCRT, all compilation units (I.e. source files that compiled to object files) must include only the two categories of header files list below. If one of the header files that was being include does not fall into one of those two categories than there is a good chance that that your Pin tool won't be able to compile, link, or run.
The two categories of header files supported by PinCRT:

1. PinCRT and Pin header files (that reside on one of the Pin kit subdirectories).
2. System headers which are PinCRT-enabled – see the list of PinCRT enabled system headers.

How to make sure my source includes only PinCRT compatible headers:

We recommend using the GCC/Clang "-E" flag,or Visual Studio's "/E" flag to dump the raw output of the C/C++ preprocessor output.
From this output you can see all the files that are being included in the compilation of the source file.
Make sure each of the files included (either directly or indirectly by you source file) falls into one of the two categories above.

PinCRT-enabled system headers

The header files below belongs to native CRTs, but may be included from PinCRT enabled Pin tool:

Linux (headers from glibc)

- stddef.h
- stdarg.h
- float.h

Windows (Visual Studio's libc)

- intrin.h
- xmmintrin.h
- windows.h (with some restrictions).

Make sure you're linking your Pin tool with PinCRT libraries

When linking a Pin tool with PinCRT, all the libraries which you tool depends on must be linked with PinCRT as well.
Also, linking with a native CRT (e.g. glibc, or Visual Studio CRT) is not possible.
This means that you might need to rebuild some libraries that your tool is using so they'll be linked with PinCRT.
If one of the libraries your tool is linked against (either directly, or indirectly) is linked with other C-Runtime than PinCRT this would lead to crashes when running it with Pin.
How to check the libraries your tool depends on

On Linux

From a Linux terminal, run:
ldd <your tool shared object file>
These are the valid PinCRT libraries that you should see:

- libc-dynamic.so
- libdl-dynamic.so
- libm-dynamic.so
- libc++.so
- libc++abi.so
- libpindwarf.so
- libdwarf.so
- libxed.so
- linux-vdso.so.1 (Not part of PinCRT but valid as well).

Below are the libraries that should *not* be seen in the output.
Note that if you spot a shared object that depends on one of the libraries listed below, then this shared object must be rebuilt with PinCRT so it won't depend on any of them libraries:

- libc.so.6
- libm.so.6
- libgcc_s.so.1
- libstdc++.so.6
- Any library under the directories: /lib, /lib32, and /lib64

Any other library in the output of "ldd" must be inspected again for dependent libraries using "ldd".

On Windows

From Visual Studio command line prompt, run:
dumpbin /DEPENDENTS <your tool DLL file>
And look at all of the dependencies of your DLL.
These are the valid PinCRT libraries that you should see:

- pincrt.dll
- kernel32.dll – works for now but might not be working in future version of Pin. The reason is that when using it Pin tool might undesirably interfere with the application.
- Non-system DLLs that you explicitly specified in link time, and you already checked it with using this procedure with "dumpbin".

If you spot any other library in the dependents list then the library we investigated must be rebuilt with PinCRT so it won't depend on any of the libraries.

Re-build any third party library with PinCRT

If your Pin tool is using a third party library then this library most probably needs to be re-built again from source with PinCRT.
Actually, the only case when a third party library may not be rebuilt is when dealing with a library which doesn't require any libc services – which is quite rare.

Common issues that may happen during the migration

Problem:
You encounter one of the error messages below when trying to run Pin:

E: Unable to load XXX: dlopen failed: cannot locate symbol "stdout" referenced by "XXX"...
E: Unable to load XXX: dlopen failed: cannot locate symbol "stderr" referenced by "XXX"...

Solution:
You most probably built your tool (or at least one of the object files that were linked to your tool) with the native CRT headers instead of PinCRT headers.

1. Locate the object(s) file that was/were built with the wrong header files.
2. Make sure you added the required compilation flags to the compilation command line of the object files you found.
3. If you sure you used the right compilation command line then see the section: “How to make sure my source includes only PinCRT compatible headers”.

Problem:
You encounter one of the error messages below when trying to build your Pin tool:

Compiler error:
error: exception handling disabled, use -fexceptions to enable

Linker error:
undefined reference to ` cxa_allocate_exception'...
undefined reference to ` cxa_throw'
unresolved external symbol CxxThrowException@8 referenced in function …

Solution:
C++ exceptions is currently not supported in PinCRT. In the meantime, you’ll have to rewrite your program not to use exceptions.
If you’re getting one of the linker errors, make sure you added all of the PinCRT compilation flags specified in this document – in particular –fno-exceptions on clang and gcc, and /EHs- /EHa- in Visual Studio.
This will make the compiler notify you about the exact locations in your source where you used C++ exceptions.

You encounter one of the error messages below when trying to build your Pin tool:

Compiler warning:
warning C4541: 'dynamic_cast' used on polymorphic type 'XXX' with /GR-; unpredictable behavior may result

Linker error:
error LNK2019: unresolved external symbol___RTDynamicCast referenced in function …
error LNK2001: unresolved external symbol "const type_info::`vftable'"
undefined reference to ` dynamic_cast'
undefined reference to ` cxa_bad_cast'
undefined reference to `vtable for cxxabiv1:: vmi_class_type_info'
undefined reference to `vtable for cxxabiv1:: class_type_info'
undefined reference to ` gxx_personality_v0'

Solution:
C++ Runtime type information (RTTI) and dynamic cast are currently not supported in PinCRT. In the meantime, you'll have to rewrite your program not to use RTTI or dynamic casts.
If you're getting one of the linker errors, make sure you added all of the PinCRT compilation flags specified in this document – in particular –fno-rtti on clang and gcc, and /GR- in Visual Studio.
This will make the compiler notify you about the exact locations in your source where you used C++ RTTI or dynamic cast.

Problem:
You encounter one of the error messages below when trying to build your Pin tool:

Linker error:
error LNK2019: unresolved external symbol @ security_check_cookie@4 referenced in function …
error LNK2019: unresolved external symbol___security_cookie referenced in function …
undefined reference to ` stack_chk_fail'

Solution:
One or more of the object files you're trying to link was compiled with the stack protector feature (or security check in Visual Studio).
Locate the faulty object files (by locating object files with undefined reference to the symbols that the linker complains about), and, make sure you added all of the required compilation flags specified in this document – in particular –fno-stack-protector on clang and gcc, and /GS- in Visual Studio.

You encounter one of the error messages below when trying to build your Pin tool:

Linker error:
undefined reference to ` dso_handle'
error LNK2001: unresolved external symbol _fltused
error LNK2001: unresolved external symbol atexit
error LNK2019: unresolved external symbol _CRT_INIT referenced in function Ptrace_DllMainCRTStartup

Solution:
You probably didn't link your Pin tool with one (or two) of the object files crtbeginS.o, crtbegin.o, crtendS.o, crtend.o, crtbeginS.obj, crtbegin.obj.
The exact files set that you need depends on the target OS of your Pin tool and whether you're trying to build shared library (Pin tool) or executable (stand alone tool).
Please refer to the specific linkage instructions for more details.

Problem:
After migrating a Pin tool from using MS-CRT to PinCRT all *wprintf() function started to act weird.
In particular, the "%s" format doesn't format a string correctly.

Solution:
There is a difference between MS-CRT's *wprintf() functions and almost every other CRT's (including PinCRT's) *wprintf():

- In MS-CRT: the default strings in *wprintf() are wide characters (UTF16) so specifying "%s" in *wprintf() function actually means "%ls".
- In PinCRT (and glibc): the default strings in *wprintf() are multi-bytes characters (UTF8).

The code you ported from MS-CRT that calls *wprintf() probably expects a wide characters argument wherever a "%s" was specified in the format string.
So the best solution would be to replace all the "%s" in the format string to *wprintf() to "%ls".

Problem:
On Visual Studio, you encounter one of the error messages below when trying to build your Pin tool:

Linker error:
error LNK2019: unresolved external symbol Cilog
error LNK2019: unresolved external symbol libm_sse2_log_precise
or any error in this form:
error LNK2019: unresolved external symbol Ci*
error LNK2019: unresolved external symbol libm_*

Solution:

You forgot to add the /Oi- compiler flag when you compiled the object file with the missing reference.