Debugging Mac OSX Applications with IDA Pro

Table of Contents

Last updated on March 6, 2021 — v2.0

1. Overview

IDA Pro fully supports debugging native macOS applications.

Intel x86/64 debugging has been supported since IDA 5.6 (during OSX 10.5 Leopard), but due to IDA's use of libc++ we can only officially support debugging on OSX 10.9 Mavericks and later. Apple Silicon arm64 debugging for macOS11 is also supported since IDA 7.6.

Note that this task is riddled with gotchas, and often times it demands precise workarounds that are not required for other platforms. In this tutorial we will purposefully throw ourselves into the various pitfalls of debugging on a Mac, in the hopes that learning things the hard way will ultimately lead to a smoother experience overall.

Begin by downloading samples.zip which contains the sample applications used in this writeup.

2. Codesigning & Permissions

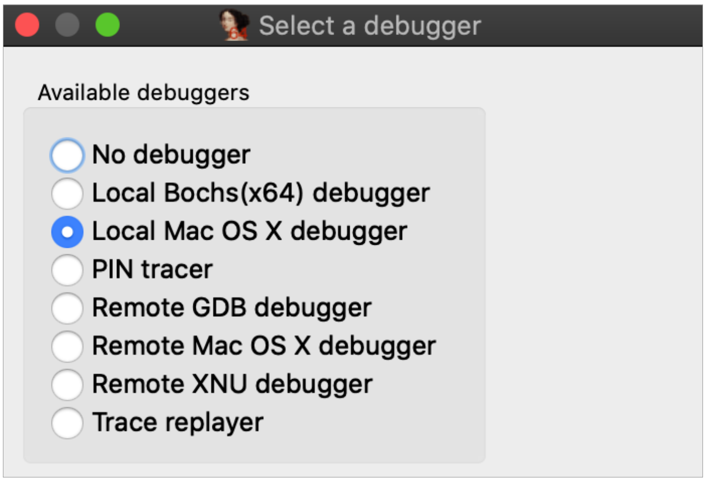
It is important to note that a debugger running on macOS requires special permissions in order to function properly. This means that the debugger itself must be codesigned in such a way that MacOS allows it to inspect other processes.

The main IDA Pro application is *not* codesigned in this way. Later on we'll discuss why.

To quickly demonstrate this, let's open a binary in IDA Pro and try to debug it. In this example we'll be debugging the **helloworld** app from samples.zip on MacOSX 10.15 Catalina using IDA 7.5. Begin by loading the file in IDA:

```
$ alias ida64="/Applications/IDA\ Pro\ 7.5/ida64.app/Contents/MacOS/ida64"
$ ida64 helloworld
```

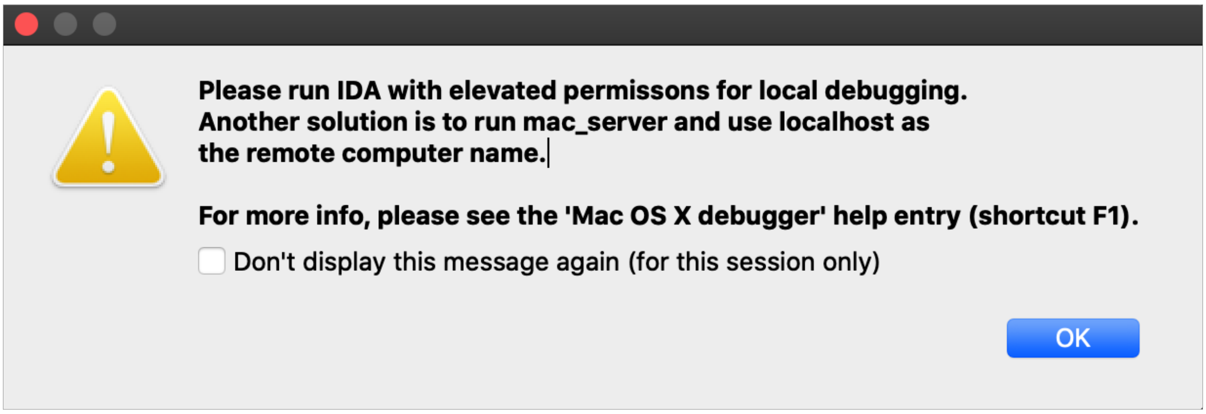
Now go to menu **Debugger>Select debugger** and select **Local Mac OS X Debugger**:



Immediately IDA should print a warning message to the Output window:

```
This program must either be codesigned or run as root to debug mac applications.
```

This is because IDA is aware that it is not codesigned, and is warning you that attempting to debug the target application will likely fail. Try launching the application with shortcut **F9**. You will likely get this error message:



Codesigning IDA Pro might resolve this issue, but we have purposefully decided not to do this. Doing so would require refactoring IDA's internal plugin directory structure so that it abides by Apple's bundle structure guidelines. This would potentially break existing plugins as well as third-party plugins written by users. We have no plans to inconvenience our users in such a way.

Also note that running IDA as root will allow you to use the Local Mac OS X Debugger without issue, but this is not advisable.

A much better option is to use IDA's mac debug server - discussed in detail in the next section.

3. Using the Mac Debug Server

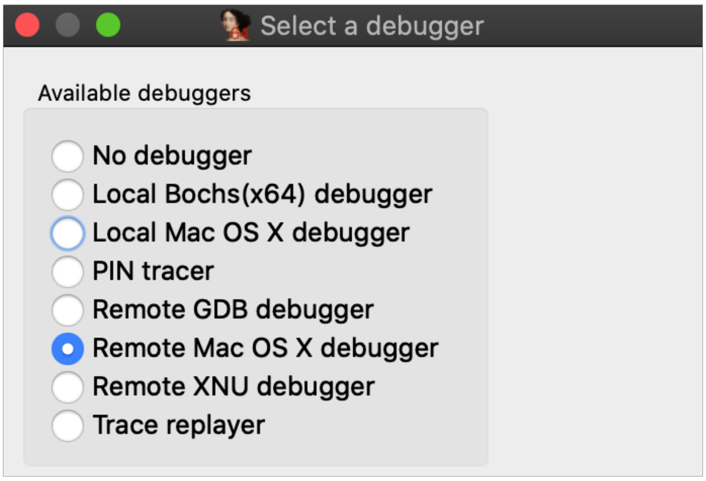
A good workaround for the debugging restrictions on macOS is to use IDA's debug server - even when debugging local apps on your mac machine. The mac debug server is a standalone application that communicates with IDA Pro via IPC, so we can ship it pre-codesigned and ready for debugging right out of the box:

```
$ codesign -dvv /Applications/IDA\ Pro\ 7.5/idabin/dbgsrv/mac_server64
Executable=/Applications/IDA Pro 7.5/ida.app/Contents/MacOS/dbgsrv/mac_server64
Identifier=com.hexrays.mac_serverx64
Format=Mach-O thin (x86_64)
CodeDirectory v=20100 size=6090 flags=0x0(none) hashes=186+2 location=embedded
Signature size=9002
Authority=Developer ID Application: Hex-Rays SA (ZP7XF62S2M)
Authority=Developer ID Certification Authority
Authority=Apple Root CA
Timestamp=May 19, 2020 at 4:13:31 AM
```

Let’s try launching the server:

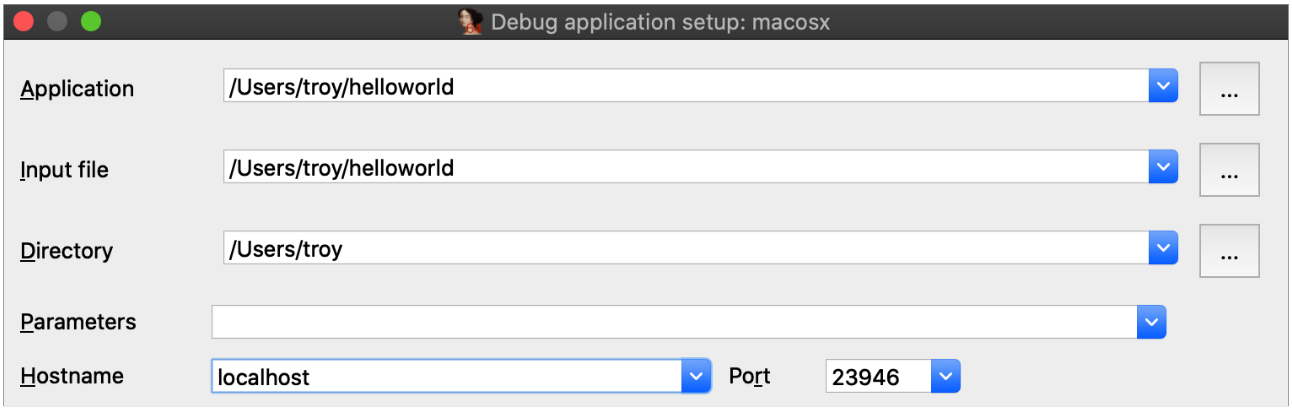
```
$ /Applications/IDA\ Pro\ 7.5/idabin/dbgsrv/mac_server64
IDA Mac OS X 64-bit remote debug server(MT) v7.5.26. Hex-Rays (c) 2004-2020
Listening on 0.0.0.0:23946...
```

Now go back to IDA and use menu **Debugger>Switch debugger** to switch to remote debugging:



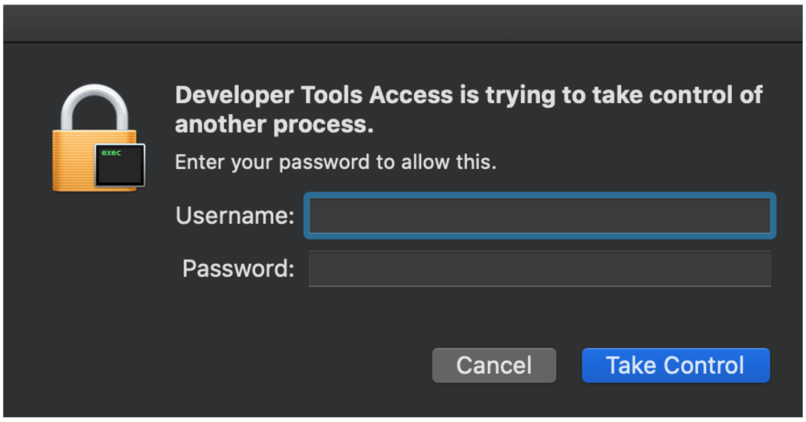
Now use **Debugger>Process options** to set the **Hostname** and **Port** fields to **localhost** and **23946**.

(Note that the port number was printed by mac_server64 after launching it):



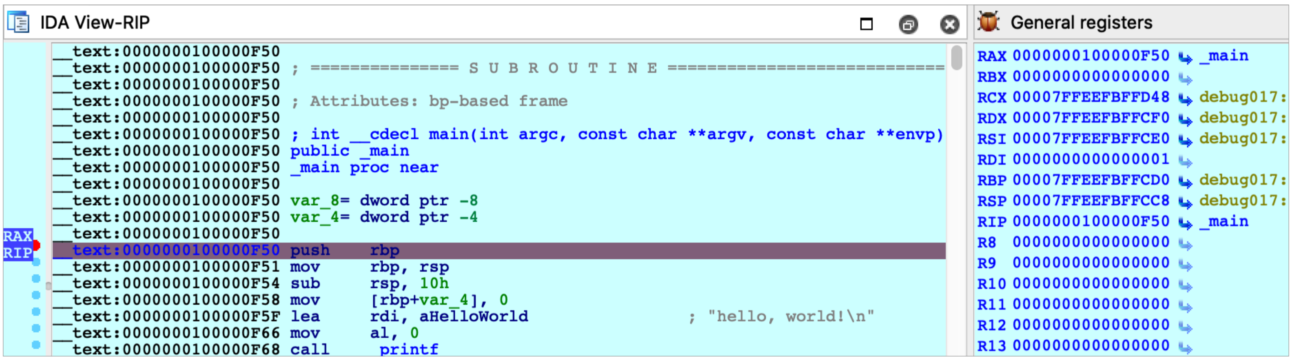
Also be sure to check the option **Save network settings as default** so IDA will remember this configuration.

Now go to **_main** in the helloworld disassembly, press **F2** to set a breakpoint, then **F9** to launch the process. Upon launching the debugger you might receive this prompt from the OS:



macOS is picky about debugging permissions, and despite the fact that mac_server is properly codesigned you still must explicitly grant it permission to take control of another process. Thankfully this only needs to be done once per login session, so macOS should shut up until the next time you log out (we discuss how to disable this prompt entirely in the Debugging Over SSH section below).

After providing your credentials the debugger should start up without issue:



3.1. Using a Launch Agent

To simplify using the mac server, save the following XML as com.hexrays.mac_server64.plist in ~/Library/LaunchAgents/:

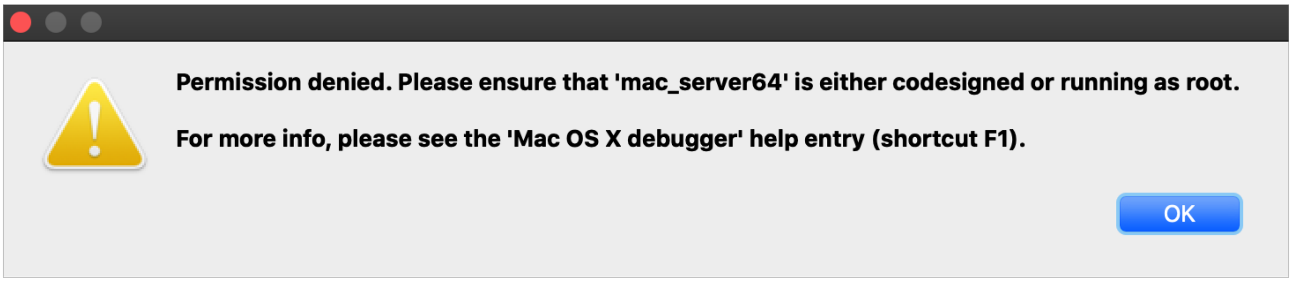
```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN" "http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
    <key>Label</key>
    <string>com.hexrays.mac_server64</string>
    <key>ProgramArguments</key>
    <array>
        <string>/Applications/IDA Pro 7.5/dbgsrv/mac_server64</string>
        <string>-i</string>
        <string>localhost</string>
    </array>
    <key>StandardOutPath</key>
    <string>/tmp/mac_server64.log</string>
    <key>StandardErrorPath</key>
    <string>/tmp/mac_server64.log</string>
    <key>KeepAlive</key>
    <true/>
</dict>
</plist>
```

Now mac_server64 will be launched in the background whenever you log in. You can connect to it from IDA at any time using the **Remote Mac OS X Debugger** option. Hopefully this will make local debugging on macOS almost as easy as other platforms.

4. Debugging System Applications

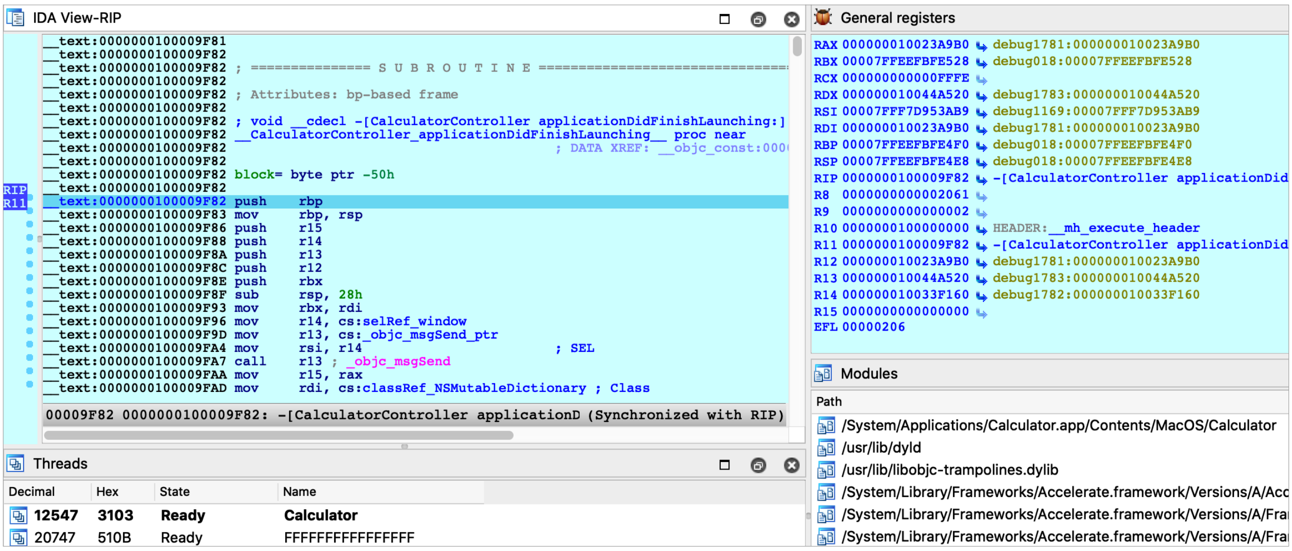
There are some applications that macOS will refuse to allow IDA to debug.

For example, load /System/Applications/Calculator.app/Contents/MacOS/Calculator in IDA and try launching the debugger. You will likely get this error message:

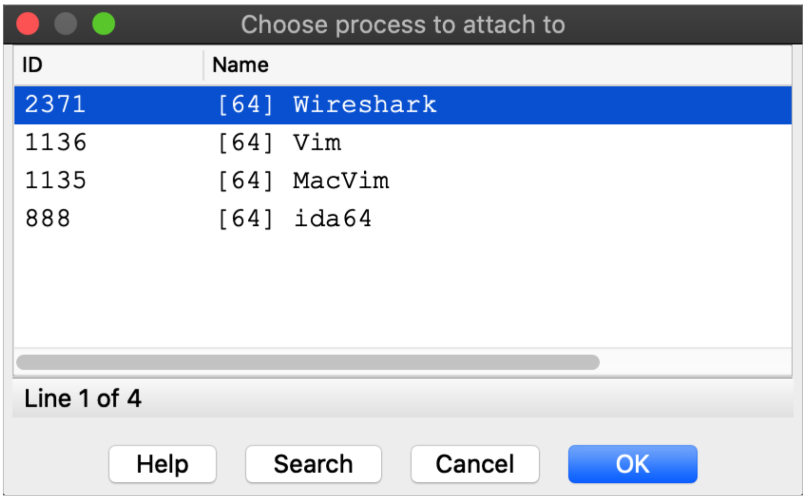


Despite the fact that mac_server64 is codesigned, it *still* failed to retrieve permission from the OS to debug the target app. This is because Calculator.app and all other apps in /System/Applications/ are protected by System Integrity Protection and they cannot be debugged until SIP is disabled. Note that the error message is a bit misleading because it implies that running mac_server64 as root will resolve the issue - it will not. Not even root can debug apps protected by SIP.

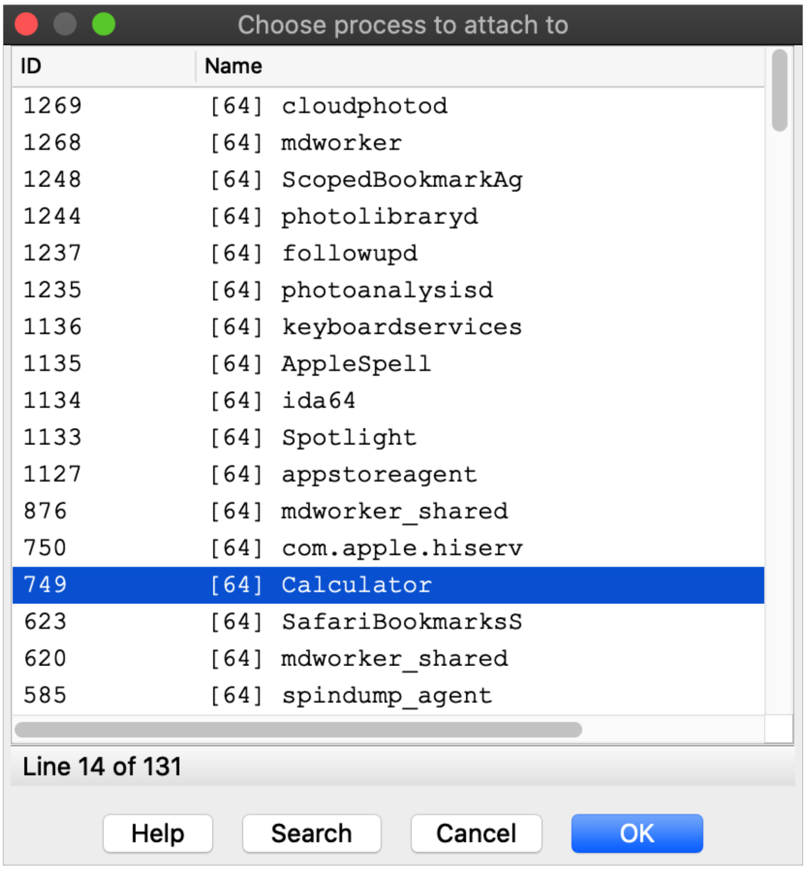
Disabling SIP allows IDA to debug applications like Calculator without issue:



The effects of SIP are also apparent when attaching to an existing process. Try using menu **Debugger>Attach to process**, with SIP enabled there will likely only be a handful of apps that IDA can debug:



Disabling SIP makes all system apps available for attach:



It is unfortunate that such drastic measures are required to inspect system processes running on your own machine, but this is the reality of MacOS. We advise that you only disable System Integrity Protection when absolutely necessary, or use a virtual machine that can be compromised with impunity.

5. Debugging System Libraries

With IDA you can debug any system library in /usr/lib/ or any framework in /System/Library/.

This functionality is fully supported, but surprisingly it is one of the hardest problems the mac debugger must handle. To demonstrate this, let's try debugging the **_getaddrinfo** function in libsystem_info.dylib.

Consider the **getaddrinfo** application from samples.zip:

```c
#include <sys/types.h>
#include <sys/socket.h>
#include <netdb.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <string.h>
#include <stdio.h>

int main(int argc, char **argv)
{
  if ( argc != 2 )
  {
    fprintf(stderr, "usage: %s <hostname>\n", argv[0]);
    return 1;
  }

  struct addrinfo hints;
  memset(&hints, 0, sizeof(hints));

  hints.ai_family = AF_INET;
  hints.ai_flags |= AI_CANONNAME;

  struct addrinfo *result;
  int code = getaddrinfo(argv[1], NULL, &hints, &result);
  if ( code != 0 )
  {
    fprintf(stderr, "failed: %d\n", code);
    return 2;
  }

  struct sockaddr_in *addr_in = (struct sockaddr_in *)result->ai_addr;
  char *ipstr = inet_ntoa(addr_in->sin_addr);
  printf("IP address: %s\n", ipstr);

  return 0;
}
```

Try testing it out with a few hostnames:

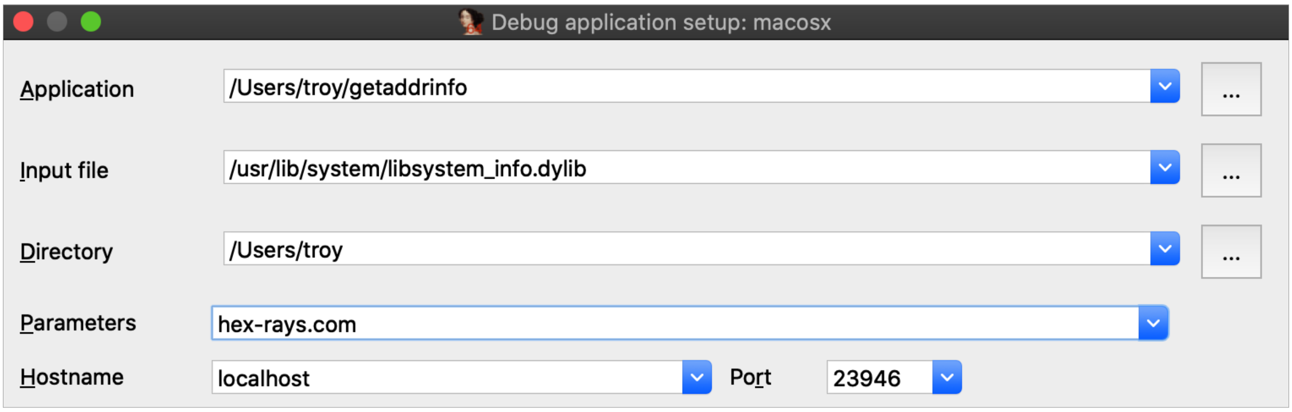
```
$ ./getaddrinfo localhost
IP address: 127.0.0.1
$ ./getaddrinfo hex-rays.com
IP address: 104.26.10.224
$ ./getaddrinfo foobar
failed: 8
```

Now load libsystem_info.dylib in IDA and set a breakpoint at **_getaddrinfo**:

```
$ ida64 -o/tmp/libsystem_info /usr/lib/system/libsystem_info.dylib
```

```
__text:0000000000008F30
__text:0000000000008F30 ; =============== S U B R O U T I N E =======================================
__text:0000000000008F30
__text:0000000000008F30 ; Attributes: bp-based frame
__text:0000000000008F30
__text:0000000000008F30 ; int __cdecl getaddrinfo(const char *, const char *, const addrinfo *, addrinfo **)
__text:0000000000008F30                 public _getaddrinfo
__text:0000000000008F30 _getaddrinfo    proc near               ; CODE XREF: _rcmd_af+154↓p
__text:0000000000008F30                                         ; _ruserok+57↓p ...
__text:0000000000008F30
__text:0000000000008F30 var_28          = qword ptr -28h
__text:0000000000008F30 var_20          = qword ptr -20h
__text:0000000000008F30 var_18          = qword ptr -18h
__text:0000000000008F30 var_10          = qword ptr -10h
__text:0000000000008F30 var_8           = qword ptr -8
__text:0000000000008F30
__text:0000000000008F30                 push    rbp
__text:0000000000008F31                 mov     rbp, rsp
__text:0000000000008F34                 sub     rsp, 30h
__text:0000000000008F38                 xor     eax, eax
__text:0000000000008F3A                 mov     r8d, eax
```

Choose **Remote Mac OS X Debugger** from the Debugger menu and under **Debugger>Process options** be sure to provide a hostname in the **Parameters** field. IDA will pass this argument to the executable when launching it:

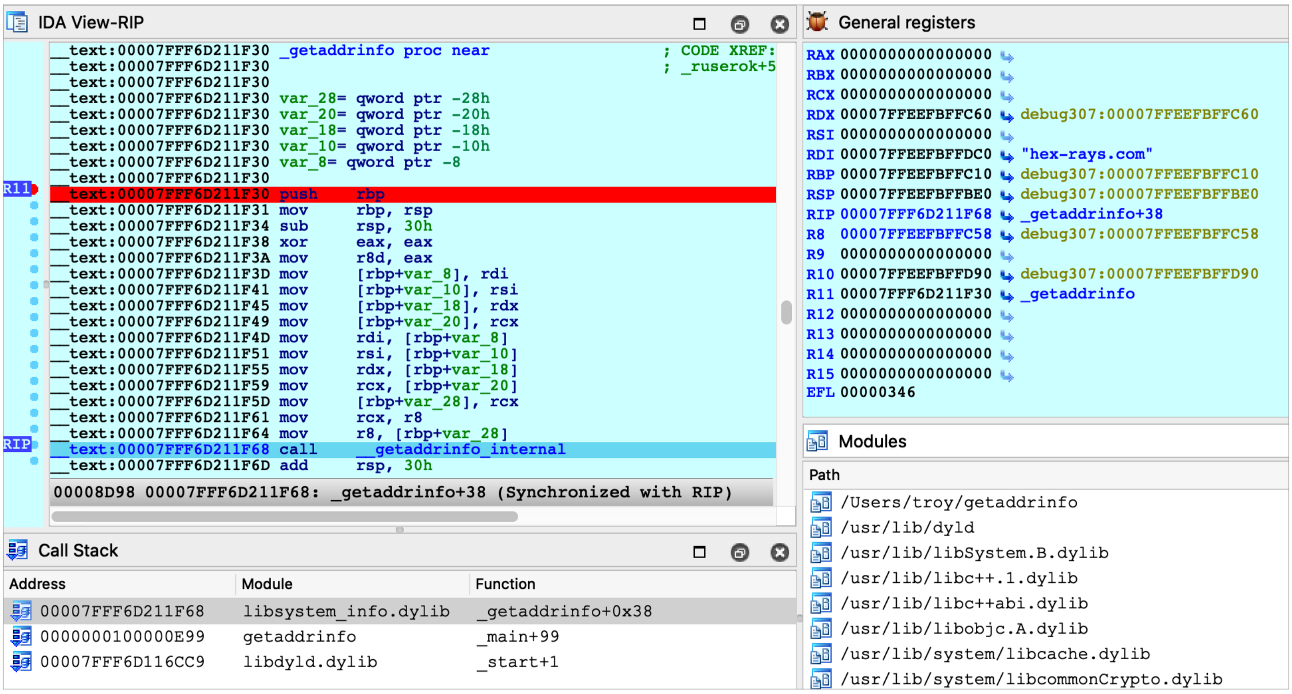


Before launching the process, use **Ctrl+S** to pull up the segment list for libsystem_info.dylib. Pay special attention to the **__eh_frame** and **__nl_symbol_ptr** segments. Note that they appear to be next to each other in memory:

Name	Start	End	R	W	X
HEADER	0000000000000000	00000000000011D0	R	.	X
__text	00000000000011D0	000000000004980A	R	.	X
__stubs	000000000004980A	0000000000049CF0	R	.	X
__stub_helper	0000000000049CF0	000000000004A52A	R	.	X
__const	000000000004A530	000000000004A6FC	R	.	X
__cstring	000000000004A6FC	000000000004CA70	R	.	X
__oslogstring	000000000004CA70	000000000004DE06	R	.	X
__unwind_info	000000000004DE08	000000000004DFA0	R	.	X
__eh_frame	000000000004DFA0	000000000004DFF8	R	.	X
__nl_symbol_ptr	000000000004E000	000000000004E008	R	W	.
__got	000000000004E008	000000000004E090	R	W	.
__la_symbol_ptr	000000000004E090	000000000004E718	R	W	.
__const	000000000004E720	000000000004F3B0	R	W	.
__data	000000000004F3B0	000000000004FB6C	R	W	.
__common	000000000004FB70	000000000004FF80	R	W	.
__bss	000000000004FF80	0000000000050578	R	W	.

This will be important later.

Finally, use **F9** to launch the debugger and wait for our breakpoint at **_getaddrinfo** to be hit. We can now start stepping through the logic:



Everything appears to be working normally, but use **Ctrl+S** to pull up the segment information again. We can still see **__eh_frame**, but it looks like **__nl_symbol_ptr** has gone missing:

HEADER	00007FFF6D209000	00007FFF6D20A1D0	R	.	X
__text	00007FFF6D20A1D0	00007FFF6D25280A	R	.	X
__stubs	00007FFF6D25280A	00007FFF6D252CF0	R	.	X
__stub_helper	00007FFF6D252CF0	00007FFF6D25352A	R	.	X
debug384	00007FFF6D25352A	00007FFF6D253530	R	.	X
__const	00007FFF6D253530	00007FFF6D2536FC	R	.	X
__cstring	00007FFF6D2536FC	00007FFF6D255A70	R	.	X
__oslogstring	00007FFF6D255A70	00007FFF6D256E06	R	.	X
debug385	00007FFF6D256E06	00007FFF6D256E08	R	.	X
__unwind_info	00007FFF6D256E08	00007FFF6D256FA0	R	.	X
__eh_frame	00007FFF6D256FA0	00007FFF6D256FF8	R	.	X
debug386	00007FFF6D256FF8	00007FFF6D257000	R	.	X
libsystem_kernel.dylib:HEADER	00007FFF6D257000	00007FFF6D257B00	R	.	.
libsystem_kernel.dylib:__text	00007FFF6D257B00	00007FFF6D279A14	R	.	X

It is actually still present, but we find it at a much higher address:

libsystem_featureflags.dylib:…	00007FFF93C39710	00007FFF93C39729	R	.	.
debug548	00007FFF93C39729	00007FFF93C39730	R	W	.
__nl_symbol_ptr	00007FFF93C39730	00007FFF93C39738	R	W	.
__got	00007FFF93C39738	00007FFF93C397C0	R	W	.
__la_symbol_ptr	00007FFF93C397C0	00007FFF93C39E48	R	W	.
debug549	00007FFF93C39E48	00007FFF93C39E50	R	W	.
__const	00007FFF93C39E50	00007FFF93C3AAE0	R	W	.
__data	00007FFF93C3AAE0	00007FFF93C3B29C	R	W	.
debug550	00007FFF93C3B29C	00007FFF93C3B2A0	R	W	.
__common	00007FFF93C3B2A0	00007FFF93C3B6B0	R	W	.
__bss	00007FFF93C3B6B0	00007FFF93C3BCA8	R	W	.
debug551	00007FFF93C3BCA8	00007FFF93C3BCB0	R	W	.
UNDEF	00007FFF93C3BCB0	00007FFF93C3C3C0	?	?	?
libsystem_kernel.dylib:__const	00007FFF93C3C3C0	00007FFF93C3E0B0	R	.	.

Recall that we opened the file directly from the filesystem (/usr/lib/system/libsystem_info.dylib). However this is actually *not* the file that macOS loaded into memory. The libsystem_info image in process memory was mapped in from the dyld_shared_cache, and the library's segment mappings were modified before it was inserted into the cache.

IDA was able to detect this situation and adjust the database so that it matches the layout in process memory. This functionality is fully supported, but it is not trivial. Essentially the debugger must split your database in half, rebase all code segments to one address, then rebase all data segments to a completely different address.

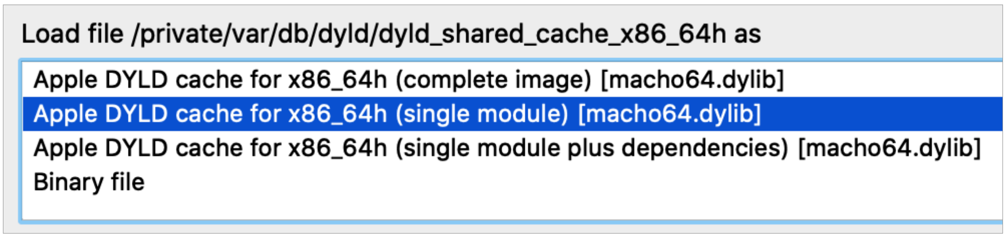
It is worth noting there is another approach that achieves the same result, but without so much complexity.

5.1. Debugging Modules in dyld_shared_cache

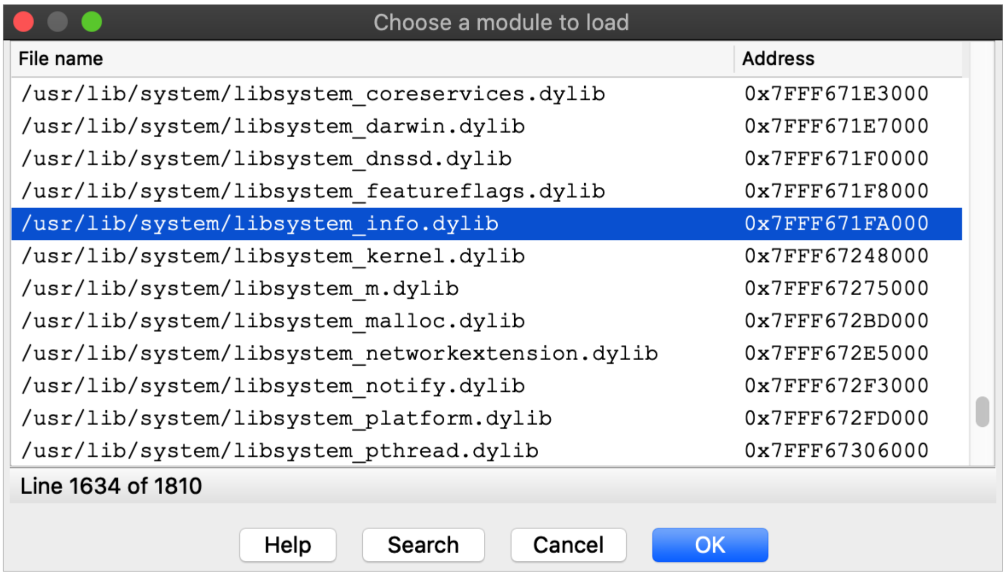
As an alternative for the above example, note that you can load any module directly from a dyld_shared_cache file and debug it. For example, open the shared cache in IDA:

```
$ ida64 -o/tmp/libsystem_info2 /var/db/dyld/dyld_shared_cache_x86_64h
```

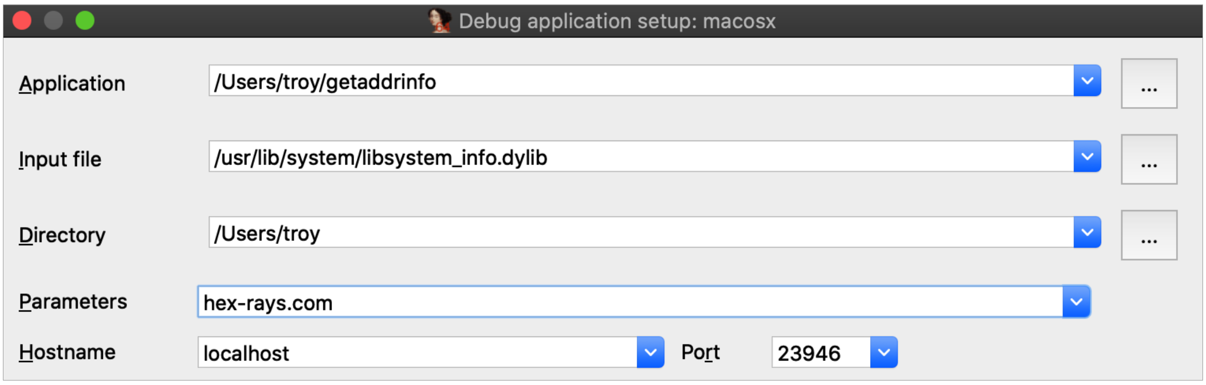
When prompted, select the "single module" option:



Then choose the libsystem_info module:

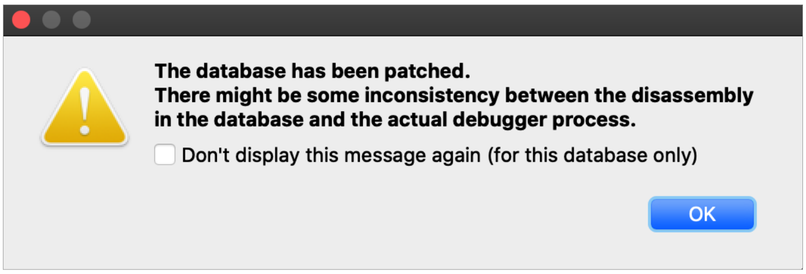


Select the **Remote Mac OS X Debugger** and for **Debugger>Process options** use the exact same options as before:



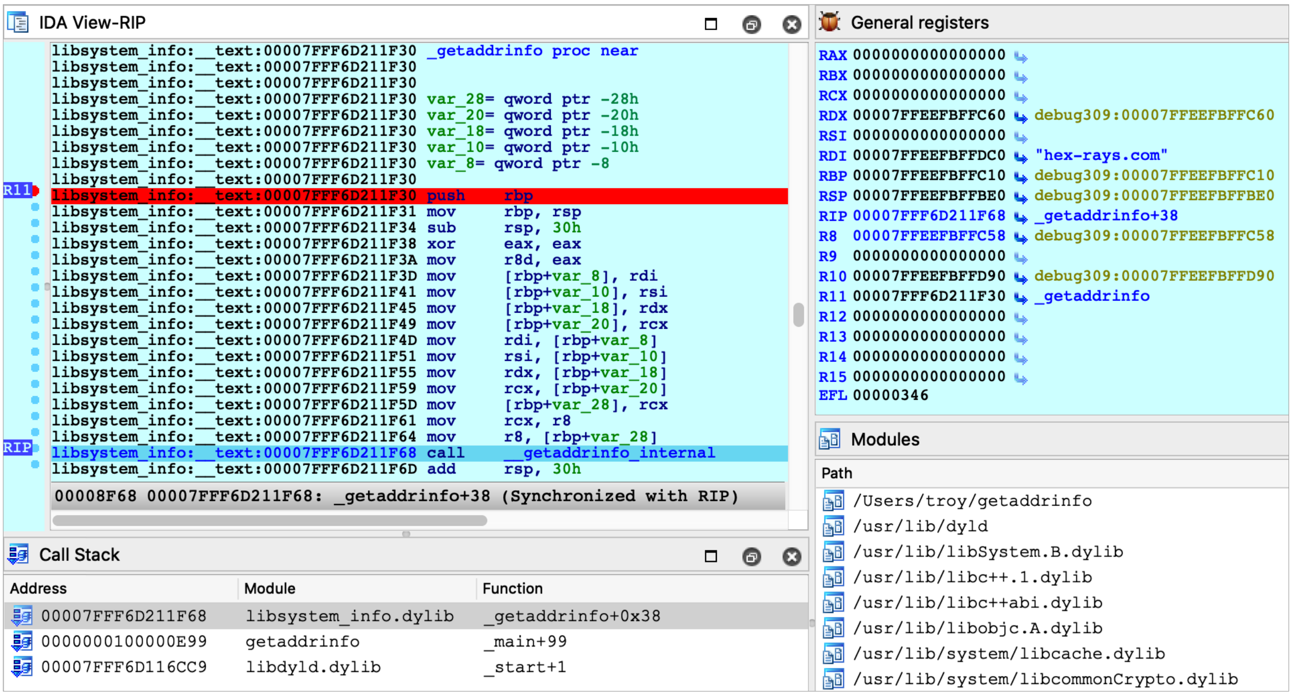
Now set a breakpoint at **_getaddrinfo** and launch the process with **F9**.

After launching the debugger you might see this warning:



This is normal. Modules from the dyld_shared_cache will contain tagged pointers, and IDA patched the pointers when loading the file so that analysis would not be hindered by the tags. IDA is warning us that the patches might cause a discrepancy between the database and the process, but in this case we know it's ok. Check **Don't display this message again** and don't worry about it.

Launching the process should work just like before, and we can start stepping through the function in the shared cache:



This time there was no special logic to map the database into process memory. Since we loaded the module directly from the cache, segment mappings already match what's expected in the process. Thus only one rebasing operation was required (as apposed to the segment scattering discussed in the previous example).

Both techniques are perfectly viable and IDA goes out of its way to fully support both of them. In the end having multiple solutions to a complex problem is a good thing.

6. Debugging Objective-C Applications

When debugging macOS applications it is easy to get lost in some obscure Objective-C framework. IDA's mac debugger provides tools to make debugging Objective-C code a bit less painful.

Consider the **bluetooth** application from samples.zip:

```
#import <IOBluetooth/IOBluetooth.h>

int main(void)
{
  NSArray *devices = [IOBluetoothDevice pairedDevices];
  int count = [devices count];
  for ( int i = 0; i < count; i++ )
  {
    IOBluetoothDevice *device = [devices objectAtIndex:i];
    NSLog(@"%@:\n", [device name]);
    NSLog(@"  paired:    %d\n", [device isPaired]);
    NSLog(@"  connected: %d\n", [device isConnected]);
  }
  return 0;
}
```

The app will print all devices that have been paired with your host via Bluetooth. Try running it:

```
$ ./bluetooth
2020-05-22 16:27:14.443 bluetooth[17025:15645888] Magic Keyboard:
2020-05-22 16:27:14.443 bluetooth[17025:15645888]   paired:    1
2020-05-22 16:27:14.443 bluetooth[17025:15645888]   connected: 1
2020-05-22 16:27:14.443 bluetooth[17025:15645888] Apple Magic Mouse:
2020-05-22 16:27:14.443 bluetooth[17025:15645888]   paired:    1
2020-05-22 16:27:14.443 bluetooth[17025:15645888]   connected: 1
2020-05-22 16:27:14.443 bluetooth[17025:15645888] iPhone SE:
2020-05-22 16:27:14.443 bluetooth[17025:15645888]   paired:    0
2020-05-22 16:27:14.443 bluetooth[17025:15645888]   connected: 0
```

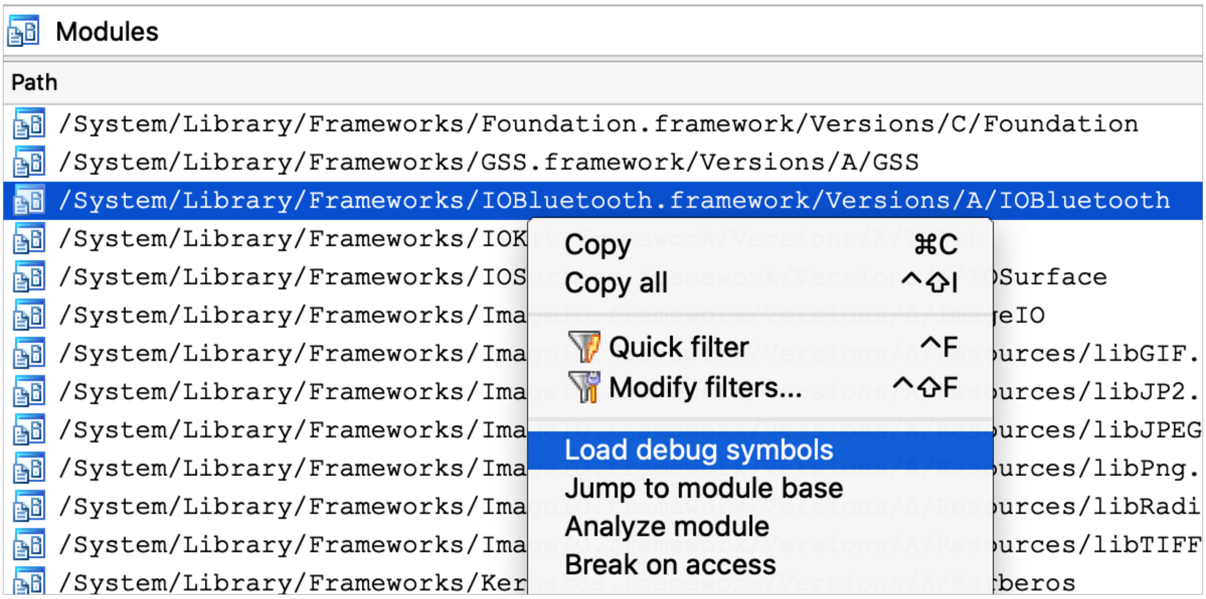
Let's try debugging this app. First consider the call to method +[IOBluetoothDevice pairedDevices]:

```
    __text:0000000100000E30 push    rbp
    __text:0000000100000E31 mov     rbp, rsp
    __text:0000000100000E34 sub     rsp, 20h
    __text:0000000100000E38 mov     [rbp+var_4], 0
    __text:0000000100000E3F mov     rax, cs:classRef_IOBluetoothDevice
    __text:0000000100000E46 mov     rsi, cs:selRef_pairedDevices    ; SEL
    __text:0000000100000E4D mov     rdi, rax                        ; id
RIP __text:0000000100000E50 call    cs:_objc_msgSend_ptr
    __text:0000000100000E56 mov     [rbp+var_10], rax
```

If we execute a regular instruction step with **F7**, IDA will step into the **_objc_msgSend** function in libobjc.A.dylib, which is probably not what we want here. Instead use shortcut **Shift+O**. IDA will automatically detect the address of the Objective-C method that is being invoked and break at it:

```
    IOBluetooth:__text:00007FFF358F7D60 ; ---------------------------------------------
    IOBluetooth:__text:00007FFF358F7D60
    IOBluetooth:__text:00007FFF358F7D60 ; +[IOBluetoothDevice pairedDevices]
RIP IOBluetooth:__text:00007FFF358F7D60 __IOBluetoothDevice_pairedDevices_:
R11 IOBluetooth:__text:00007FFF358F7D60 push    rbp
    IOBluetooth:__text:00007FFF358F7D61 mov     rbp, rsp
    IOBluetooth:__text:00007FFF358F7D64 sub     rsp, 150h
    IOBluetooth:__text:00007FFF358F7D6B mov     rax, cs:off_7FFF8AF8EF68
    IOBluetooth:__text:00007FFF358F7D72 mov     rax, [rax]
    IOBluetooth:__text:00007FFF358F7D75 mov     [rbp-8], rax
```

This module appears to be Objective-C heavy, so it might be a good idea to extract Objective-C type info from the module using right click -> **Load debug symbols** in the Modules window:



This operation will extract any Objective-C types encoded in the module, which should give us some nice prototypes for the methods we're stepping in:

```
IOBluetooth:__text:00007FFF358F7D60
IOBluetooth:__text:00007FFF358F7D60 ; =============== S U B R O U T I N E =======================================
IOBluetooth:__text:00007FFF358F7D60
IOBluetooth:__text:00007FFF358F7D60 ; Attributes: bp-based frame
IOBluetooth:__text:00007FFF358F7D60
IOBluetooth:__text:00007FFF358F7D60 ; NSArray *__cdecl +[IOBluetoothDevice pairedDevices](id, SEL)
IOBluetooth:__text:00007FFF358F7D60 __IOBluetoothDevice_pairedDevices_ proc near
IOBluetooth:__text:00007FFF358F7D60                                      ; DATA XREF: IOBluetooth:__objc_const:
IOBluetooth:__text:00007FFF358F7D60
```

Let's continue to another method call - but this time the code invokes a stub for **_objc_msgSend** that IDA has not analyzed yet, so its name has not been properly resolved:

```
    IOBluetooth:__text:00007FFF358F7D91 mov     [rbp+var_A0], rax
    IOBluetooth:__text:00007FFF358F7D98 mov     rax, cs:classRef_IOBluetoothPreferences
    IOBluetooth:__text:00007FFF358F7D9F mov     rsi, cs:selRef_sharedPreferences
    IOBluetooth:__text:00007FFF358F7DA6 mov     rdi, rax
RIP IOBluetooth:__text:00007FFF358F7DA9 call    cs:off_7FFF8AF8F058
    IOBluetooth:__text:00007FFF358F7DAF mov     rsi, cs:selRef_pairedDevices_0
    IOBluetooth:__text:00007FFF358F7DB6 mov     rdi, rax
```

In this case **Shift+O** should still work:

```
    IOBluetooth:__text:00007FFF358EDDE0
    IOBluetooth:__text:00007FFF358EDDE0 ; =============== S U B R O U T I N E =======================================
    IOBluetooth:__text:00007FFF358EDDE0
    IOBluetooth:__text:00007FFF358EDDE0 ; Attributes: bp-based frame
    IOBluetooth:__text:00007FFF358EDDE0
    IOBluetooth:__text:00007FFF358EDDE0 ; id __cdecl +[IOBluetoothPreferences sharedPreferences](id, SEL)
    IOBluetooth:__text:00007FFF358EDDE0 __IOBluetoothPreferences_sharedPreferences_ proc near
    IOBluetooth:__text:00007FFF358EDDE0                                      ; DATA XREF: IOBluetooth:__objc_const:
    IOBluetooth:__text:00007FFF358EDDE0
    IOBluetooth:__text:00007FFF358EDDE0 var_28= qword ptr -28h
    IOBluetooth:__text:00007FFF358EDDE0 var_20= qword ptr -20h
    IOBluetooth:__text:00007FFF358EDDE0 var_18= qword ptr -18h
    IOBluetooth:__text:00007FFF358EDDE0 var_10= qword ptr -10h
    IOBluetooth:__text:00007FFF358EDDE0 var_8= qword ptr -8
RIP IOBluetooth:__text:00007FFF358EDDE0
R11 IOBluetooth:__text:00007FFF358EDDE0 push    rbp
    IOBluetooth:__text:00007FFF358EDDE1 mov     rbp, rsp
```

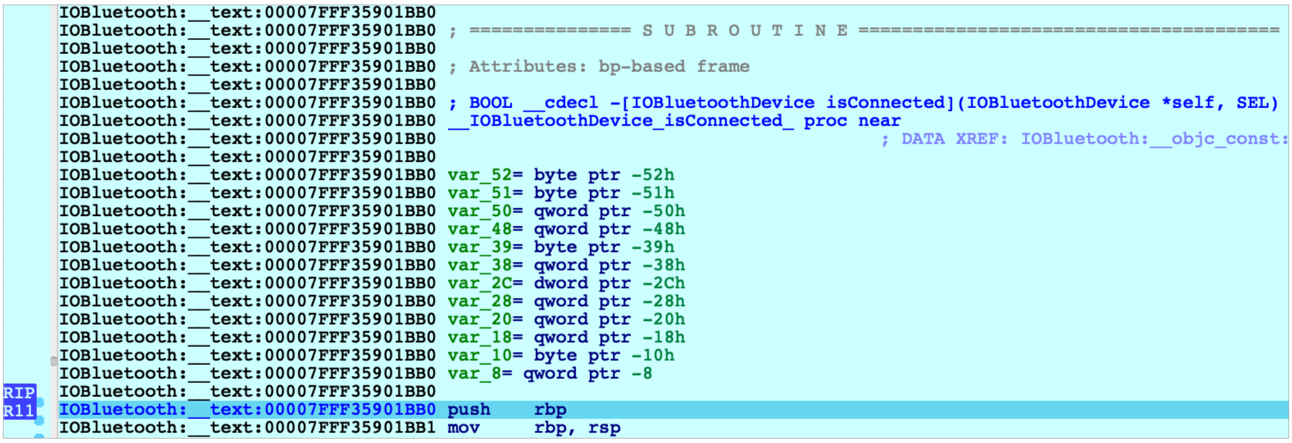
Shift+O is purposefully flexible so that it can be invoked at any point before a direct or indirect call to **_objc_msgSend**. It will simply intercept execution at the function in libobjc.A.dylib and use the arguments to calculate the target method address.

However, you must be careful. If you use this action in a process that does *not* call **_objc_msgSend**, you will lose control of the process. It is best to only use it when you're certain the code is compiled from Objective-C and an **_objc_msgSend** call is imminent.

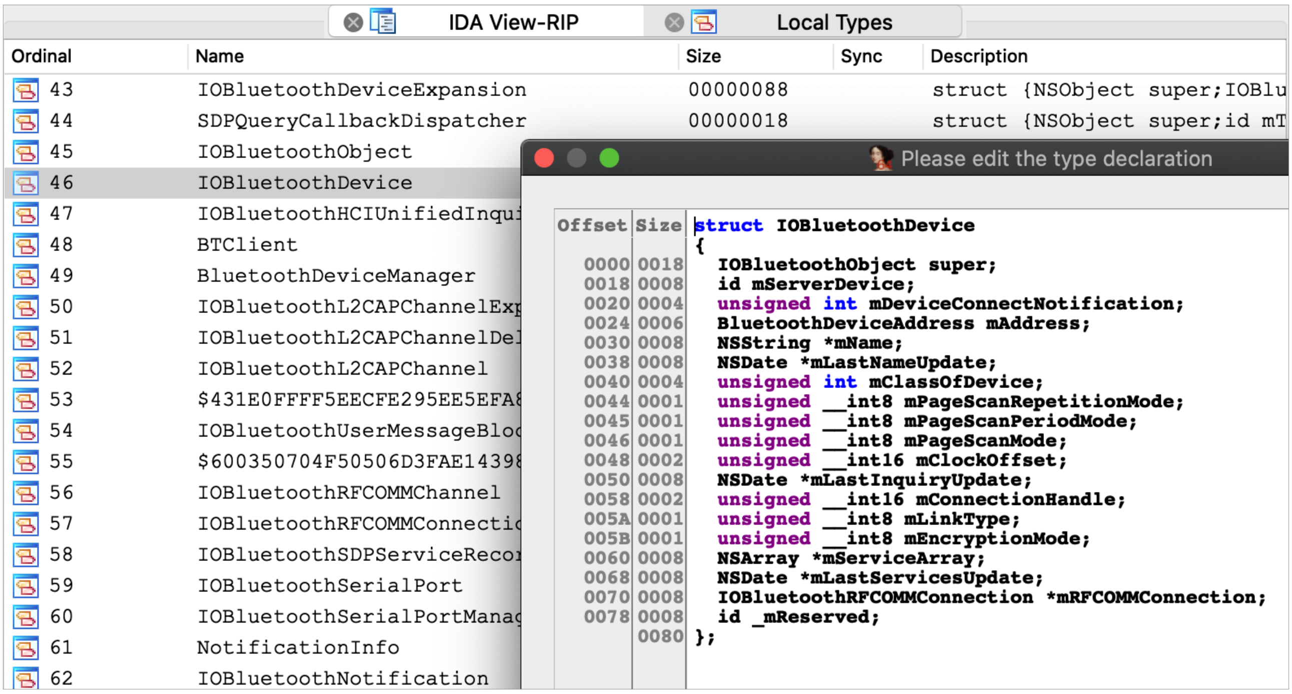
6.1. Decompiling Objective-C at Runtime

The Objective-C runtime analysis performed by **Load debug symbols** will also improve decompilation.

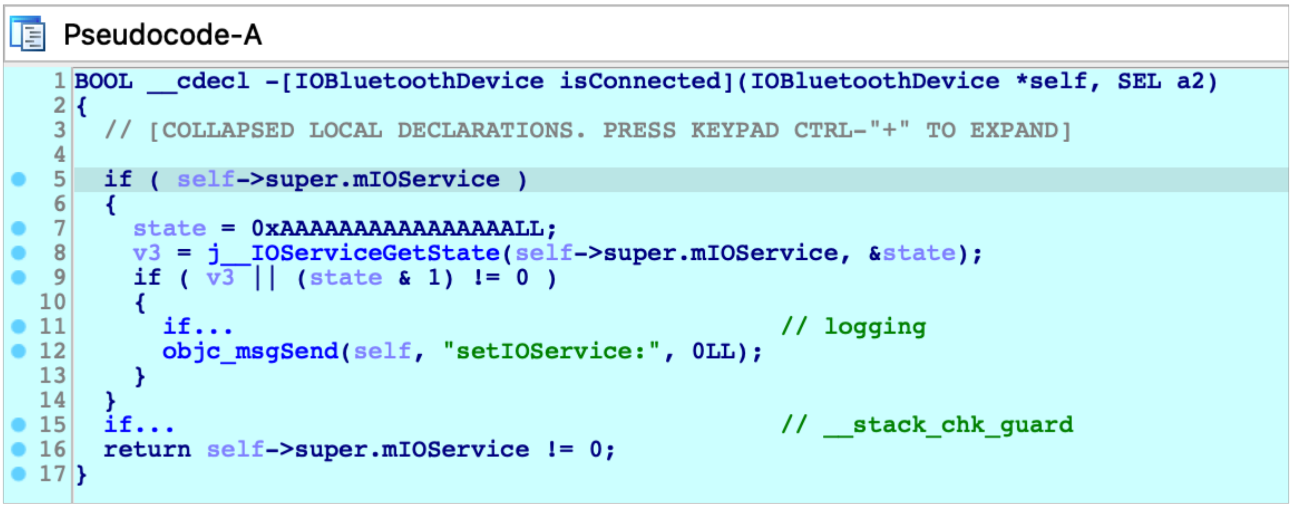
Consider the method -[IOBluetoothDevice isConnected]:



Before we start stepping through this method we might want to peek at the pseudocode to get a sense of how it works. Note that the Objective-C analysis created local types for the **IOBluetoothDevice** class, as well as many other classes:



This type info results in some sensible pseudocode:



We knew nothing about this method going in - but it's immediately clear that device connectivity is determined by the state of an **io_service_t** handle in the **IOBluetoothObject** superclass, and we're well on our way.

7. Debugging Over SSH

In this section we will discuss how to remotely debug an app on a mac machine using only an SSH connection. Naturally, this task introduces some unique complications.

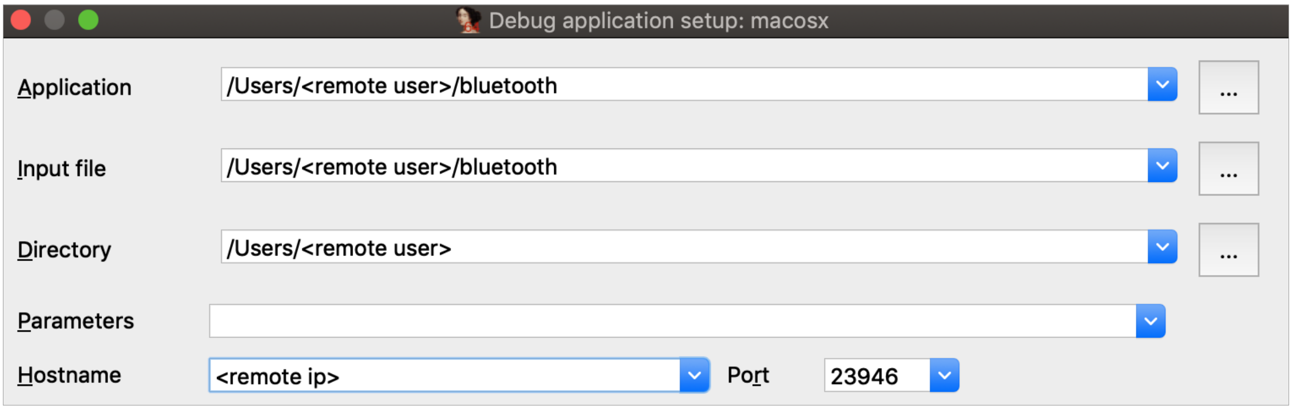
To start, copy the mac_server binaries and the **bluetooth** app from samples.zip to the target machine:

```
$ scp <IDA install dir>/dbgsrv/mac_server* user@remote:
$ scp bluetooth user@remote:
```

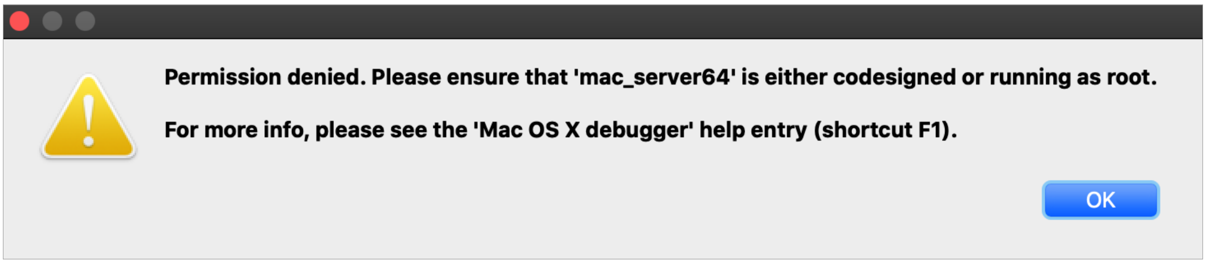
Now ssh to the target machine and launch the mac_server:

```
$ ssh user@remote
user@remote:~$ ./mac_server64
IDA Mac OS X 64-bit remote debug server(MT) v7.5.26. Hex-Rays (c) 2004-2020
Listening on 0.0.0.0:23946...
```

Now open the **bluetooth** binary on the machine with your IDA installation, select **Remote Mac OS X Debugger** from the debugger menu, and for **Debugger>Process options** set the debugging parameters. Be sure to replace **<remote user>** and **<remote ip>** with the username and ip address of the target machine:



Try launching the debugger with **F9**. You might get the following error message:



This happened because debugging requires manual authentication from the user for every login session (via the **Take Control** prompt discussed under Using the Mac Debug Server, above).

But since we're logged into the mac via SSH, the OS has no way of prompting you with the authentication window and thus debugging permissions are refused.

Note that mac_server64 might have printed this workaround:

```
WARNING: The debugger could not acquire the necessary permissions from the OS to
debug mac applications. You will likely have to specify the proper credentials at
process start. To avoid this, you can set the MAC_DEBMOD_USER and MAC_DEBMOD_PASS
environment variables.
```

But this is an extreme measure. As an absolute last resort you can launch the mac_server with your credentials in the environment variables, which should take care of authentication without requiring any interaction with the OS. However there is a more secure workaround.

In your SSH session, terminate the mac_server process and run the following command:

```
$ security authorizationdb read system.privilege.taskport > taskport.plist
```

Edit taskport.plist and change the **authenticate-user** option to **false**:

```
<key>authenticate-user</key>
<false/>
```

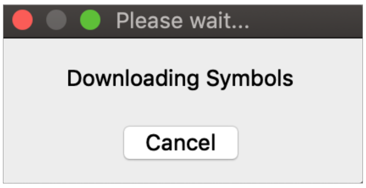
Then apply the changes:

```
$ sudo security authorizationdb write system.privilege.taskport < taskport.plist
```

This will completely disable the debugging authentication prompt (even across reboots), which should allow you to use the debug server over SSH without macOS bothering you about permissions.

7.1. Dealing With Slow Connections

When debugging over SSH you might experience some slowdowns. For example you might see this dialog appear for several seconds when starting the debugger:



During this operation IDA is fetching function names from the symbol tables for all dylibs that have been loaded in the target process. It is a critical task (after all we want our stack traces to look nice), but it is made complicated by the sheer volume of dylibs loaded in a typical macOS process due to the dyld_shared_cache. This results in several megabytes of raw symbol names that mac_server must transmit over the wire every time the debugger is launched.

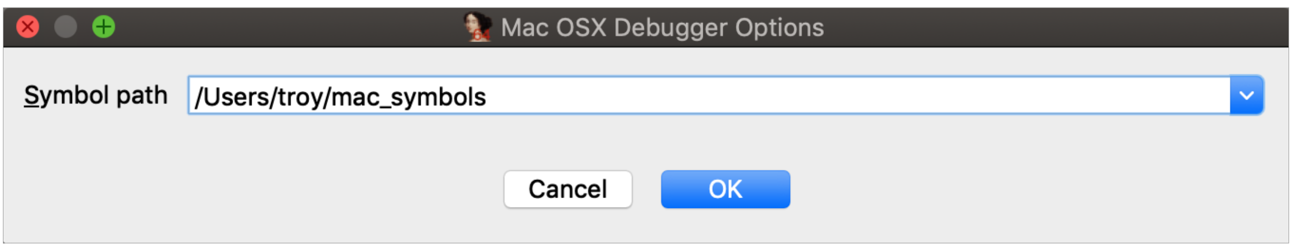
We can fix this by using the same trick that IDA's Remote iOS Debugger uses to speed up debugging - by extracting symbol files from the dyld cache and parsing them locally. Start by downloading the ios_deploy utility from our downloads page, and copy it to the remote mac:

```
$ scp ios_deploy user@remote:
```

Then SSH to the remote mac and run it:

```
$ ./ios_deploy symbols -c /var/db/dyld/dyld_shared_cache_x86_64h -d mac_symbols
Extracting symbols from /var/db/dyld/dyld_shared_cache_x86_64h => mac_symbols
Extracting symbol file: 1813/1813
mac_symbols: done
$ zip -r mac_symbols.zip mac_symbols
```

Copy mac_symbols.zip from the remote machine to your host machine and unzip it. Then open **Debugger>Debugger options>Set specific options** and set the **Symbol path** field:



Now try launching the debugger again, it should start up much faster.

Also keep the following in mind:

- Use /var/db/dyld/dyld_shared_cache_i386 if debugging 32-bit apps
- You must perform this operation after every macOS update. Updating the OS will update the dyld_shared_cache, which invalidates the extracted symbol files.
- The ios_deploy utility simply invokes **dyld_shared_cache_extract_dylibs_progress** from the **dsc_extractor.bundle** library in Xcode. If you don't want to use ios_deploy there are likely other third-party tools that do something similar.

8. Debugging arm64 Applications on Apple Silicon

IDA 7.6 introduced the ARM Mac Debugger, which can debug any application that runs natively on Apple Silicon.

On Apple Silicon, the same rules apply (see Codesigning & Permissions above). The Local ARM Mac Debugger can only be used when run as root, so it is better to use the Remote ARM Mac Debugger with the debug server (mac_server_arm64), which can debug any arm64 app out of the box (see Using the Mac Debug Server).

We have included arm64 versions of the sample binaries used in the previous examples. We encourage you to go back and try them. They should work just as well on Apple Silicon.

8.1. Debugging arm64e System Applications

Similar to Intel Macs, IDA cannot debug system apps on Apple Silicon until System Integrity Protection is disabled.

But here macOS introduces another complication. All system apps shipped with macOS are built for arm64e - and thus have pointer authentication enabled. This is interesting because ptruath-enabled processes are treated much differently within the XNU kernel. All register values that typically contain pointers (PC, LR, SP, and FP) will be signed and authenticated by PAC.

Thus, if a debugger wants to modify the register state of an arm64e process, it must know how to properly sign the register values. Only arm64e applications are allowed to do this (canonically, at least).

You may have noticed that IDA 7.6 ships with two versions of the arm64 debug server:

```
~ % ls -l /Applications/IDA\ Pro\ 7.6/dbgsrv/
total 22880
-rwxr-xr-x  1 troy  admin   799160 Mar  7 08:23 android_server
-rwxr-xr-x  1 troy  admin  1236288 Mar  7 08:23 android_server64
-rwxr-xr-x  1 troy  admin  1222776 Mar  7 08:23 android_x64_server
-rwxr-xr-x  1 troy  admin  1138296 Mar  7 08:23 android_x86_server
-rwxr-xr-x  1 troy  admin   644952 Mar  7 08:23 armlinux_server
-rwxr-xr-x  1 troy  admin   783792 Mar  7 08:23 linux_server
-rwxr-xr-x  1 troy  admin   735376 Mar  7 08:23 linux_server64
-rwxr-xr-x  1 troy  admin   811952 Mar  7 08:23 mac_server
-rwxr-xr-x  1 troy  admin   800368 Mar  7 08:23 mac_server64
-rwxr-xr-x  1 troy  admin   755264 Mar  7 08:23 mac_server_arm64
-rwxr-xr-x  1 troy  admin  1146336 Mar  7 08:23 mac_server_arm64e
-rwxr-xr-x  1 troy  admin   726016 Mar  7 08:23 win32_remote.exe
-rwxr-xr-x  1 troy  admin   886784 Mar  7 08:23 win64_remote64.exe
~ %
```

mac_server_arm64e is built specifically for the arm64e architecture, and thus will be able to properly inspect other arm64e processes. We might want to try running this version right away, but by default macOS will refuse to run any third-party software built for arm64e:

```
~ %  /Applications/IDA\ Pro\ 7.6/dbgsrv/mac_server_arm64e
zsh: killed     /Applications/IDA\ Pro\ 7.6/dbgsrv/mac_server_arm64e
~ %
```

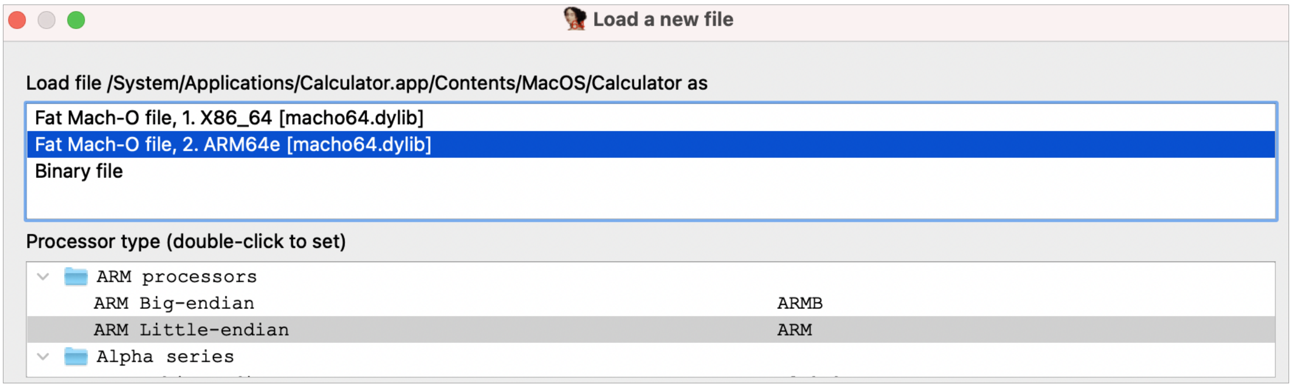
According to Apple, this is because the arm64e ABI is not stable enough to be used generically. In order to run third-party arm64e binaries you must enable the following boot arg:

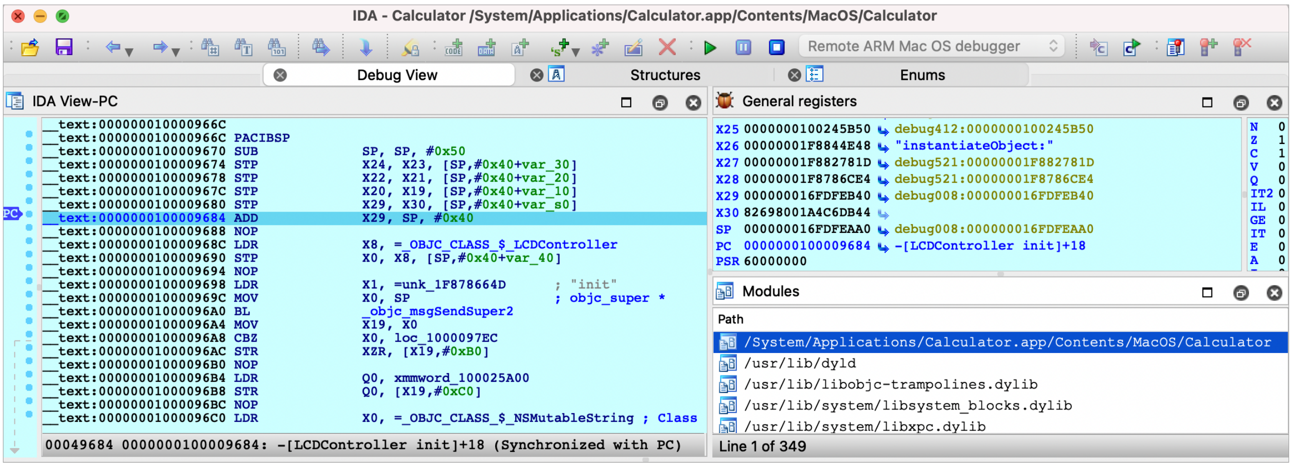
```
$ sudo nvram boot-args=-arm64e_preview_abi
```

After rebooting you can finally run mac_server_arm64e:

```
~ % /Applications/IDA\ Pro\ 7.6/dbgsrv/mac_server_arm64e
IDA Mac OS X 64-bit (sizeof ea=64) remote debug server(MT) v7.6.27. Hex-Rays (c) 2004-2021
Listening on 0.0.0.0:23946...
```

This allows you to debug any system application (e.g. /System/Applications/Calculator.app) without issue:





Also note that the arm64e ABI limitation means you cannot use the **Local** ARM Mac Debugger to debug system arm64e apps, since IDA itself is not built for arm64e. It is likely that Apple will break the arm64e ABI in the future and IDA might cease to work. We want to avoid this scenario entirely.

Using the Remote ARM Mac Debugger with mac_server_arm64e is a nice workaround. It guarantees ida.app will continue to work normally regardless of any breakages in the arm64e ABI, and we can easily ship new arm64e builds of the server to anybody who needs it.

8.2. Apple Silicon: TL;DR

To summarize:

- Use **mac_server_arm64** if you're debugging third-party arm64 apps that aren't protected by SIP
- Use **mac_server_arm64e** if you're feeling frisky and want to debug macOS system internals. You must disable SIP and enable **nvram boot-args=-arm64e_preview_abi**, then you can debug any app you want (arm64/arm64e apps, system/non-system apps, shouldn't matter).

9. Support

If you have any questions about this writeup or encounter any issues with the debugger itself in your environment, don't hesitate to contact us at support@hex-rays.com.

Our Mac support team has years of experience keeping the debugger functional through rapid changes in the Apple developer ecosystem. It is likely that we can resolve your issue quickly.