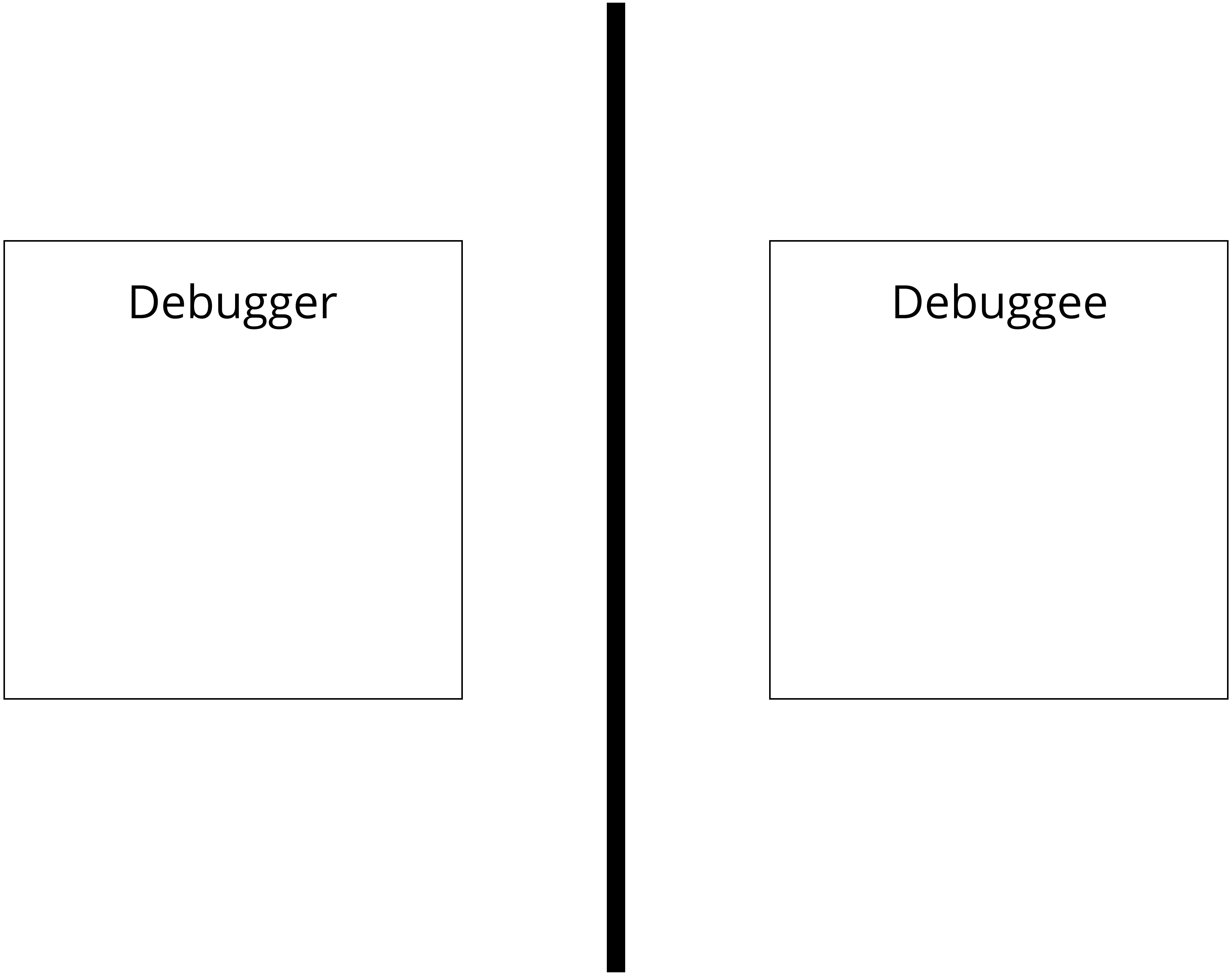
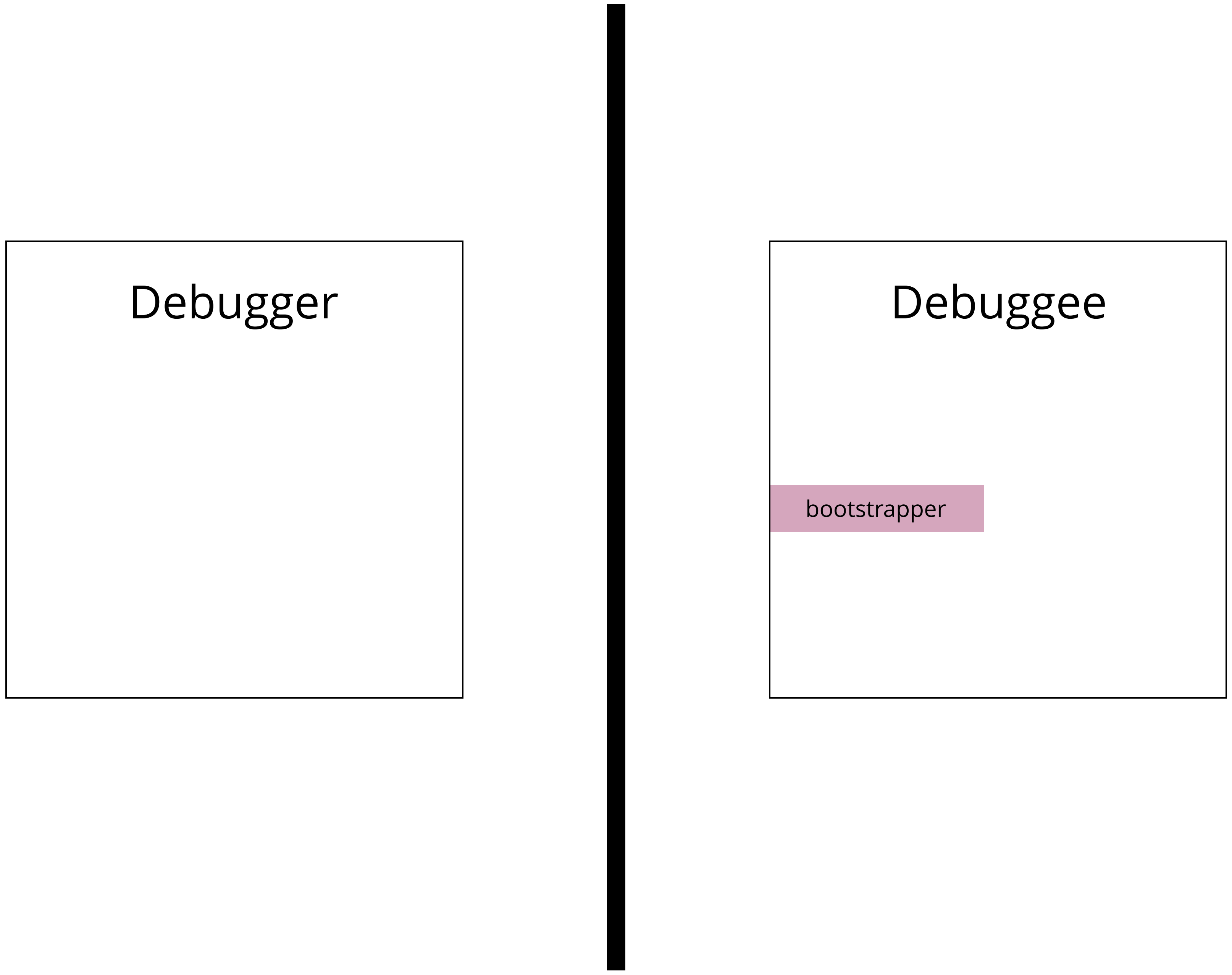
Unlocking secrets of proprietary software using

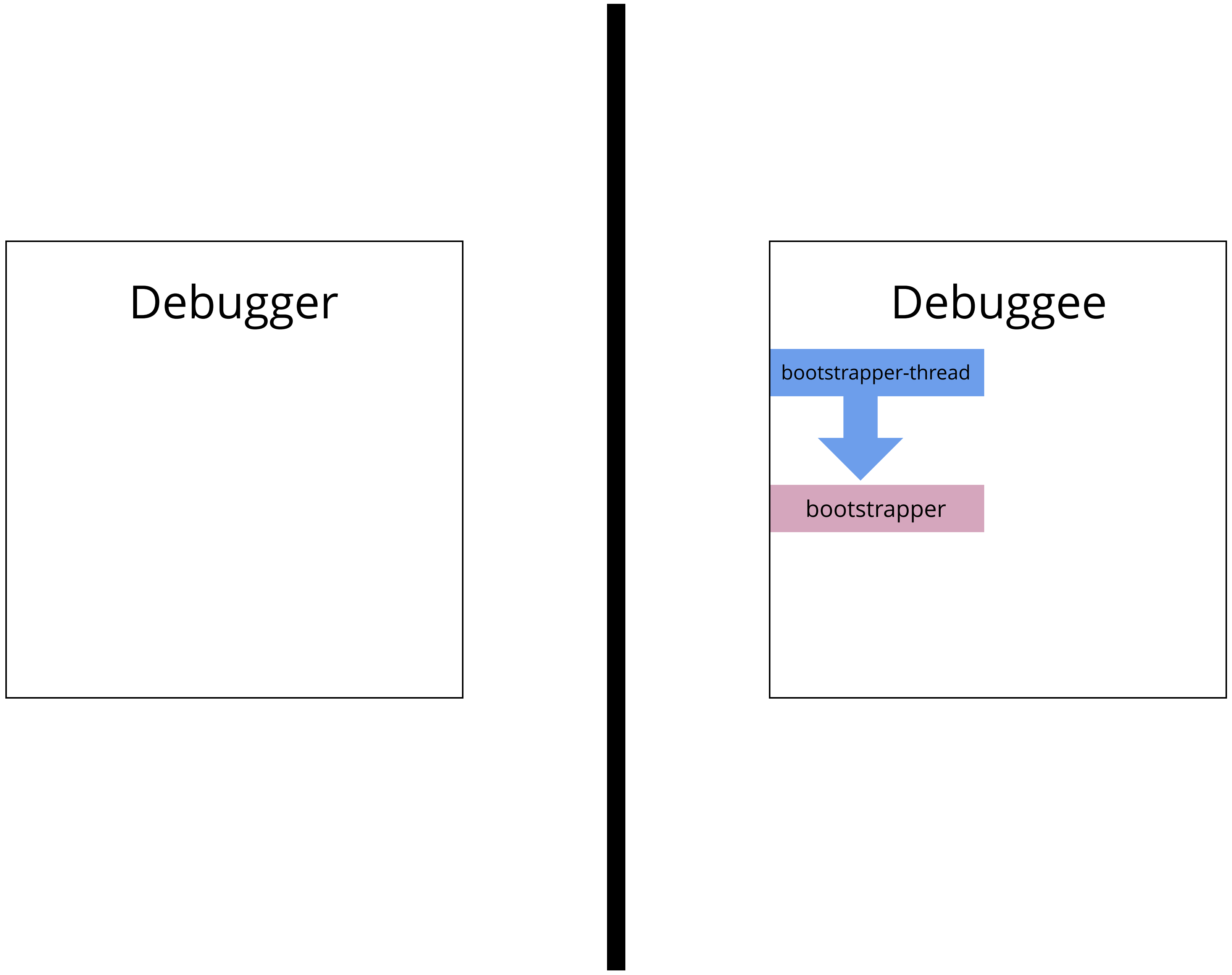
FRIDA

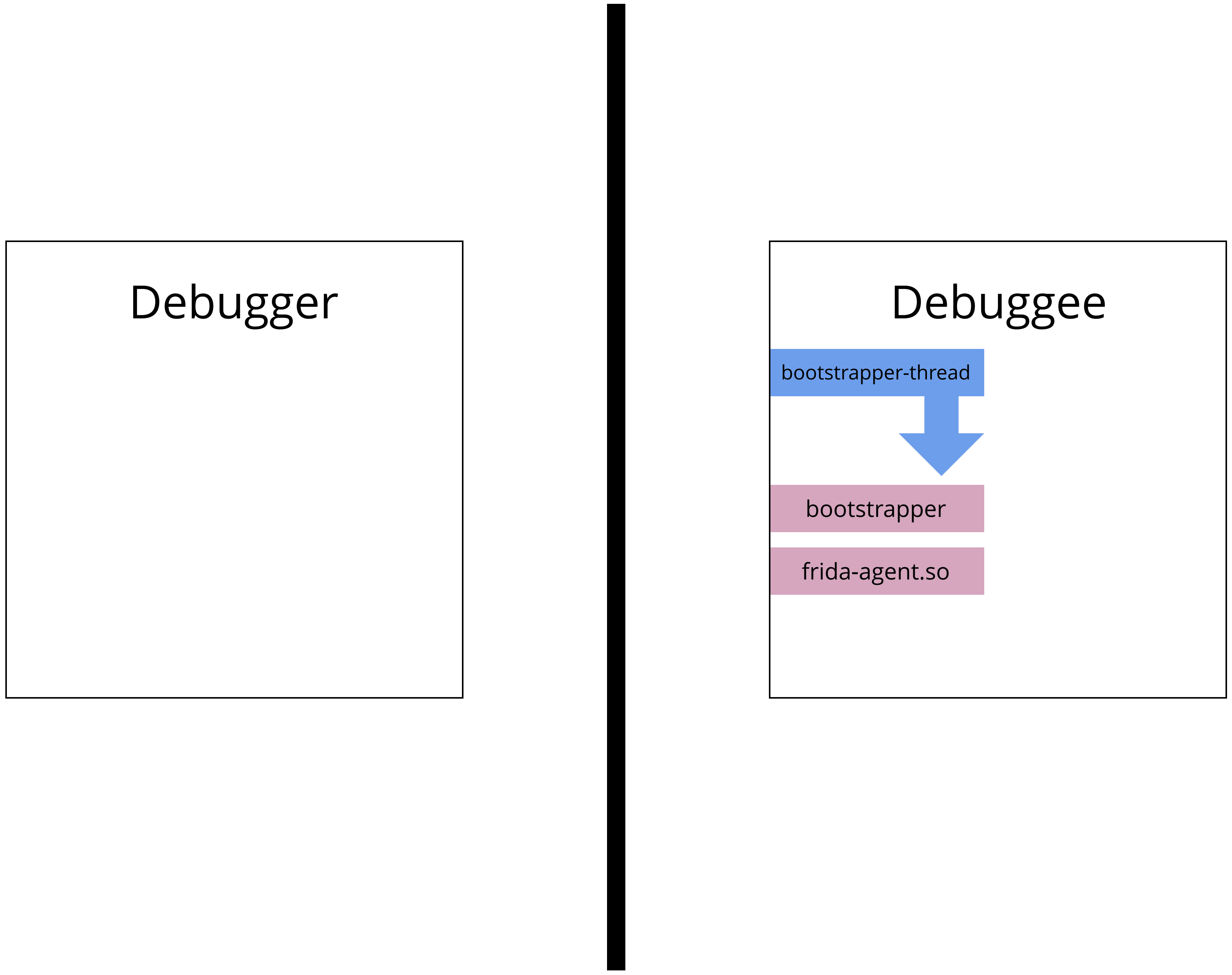
www.frida.re

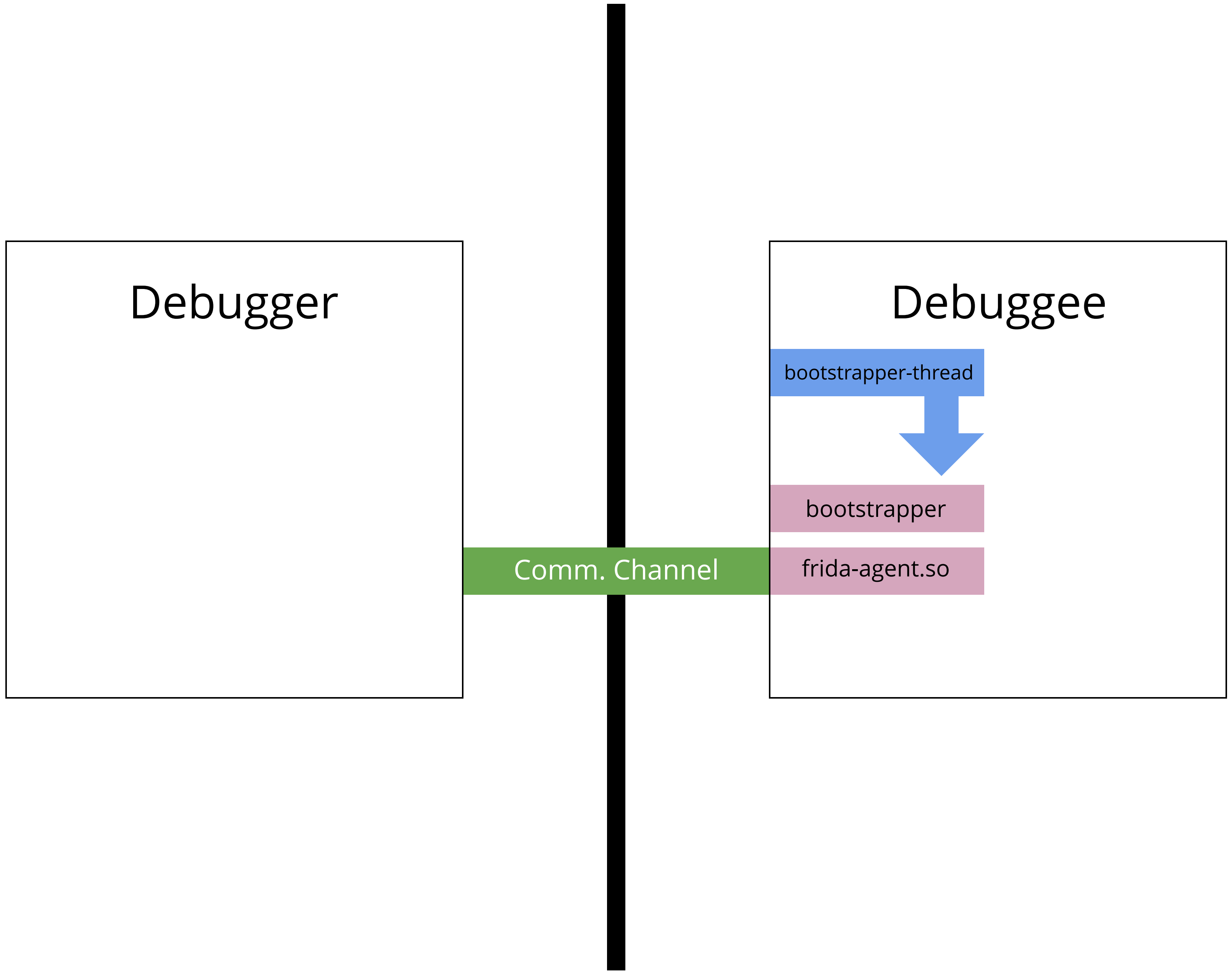
@fridadotre

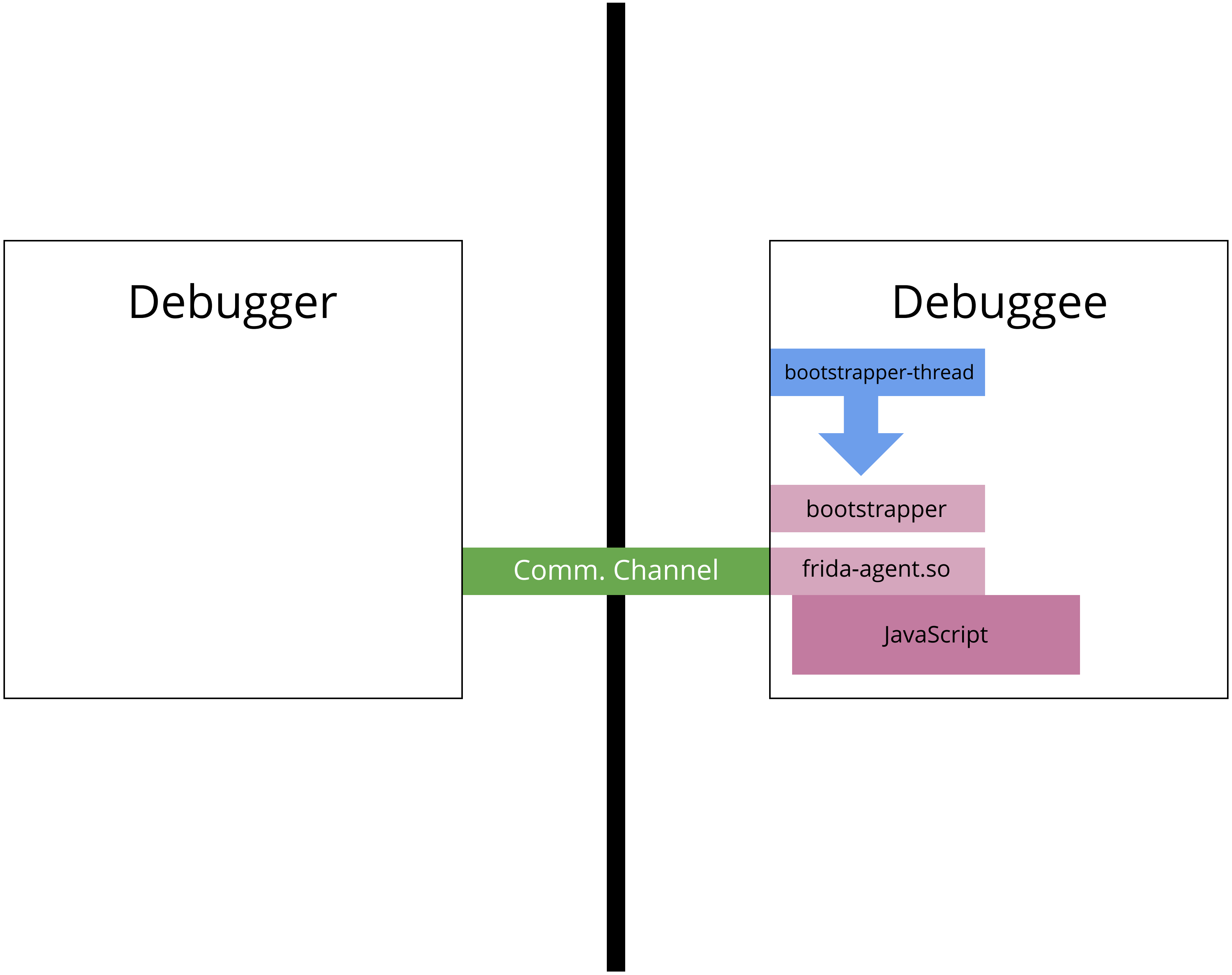

Debugger
Debuggee


Debugger
Debuggee
bootstrapper


Debugger
Debuggee
bootstrapper-thread
bootstrapper

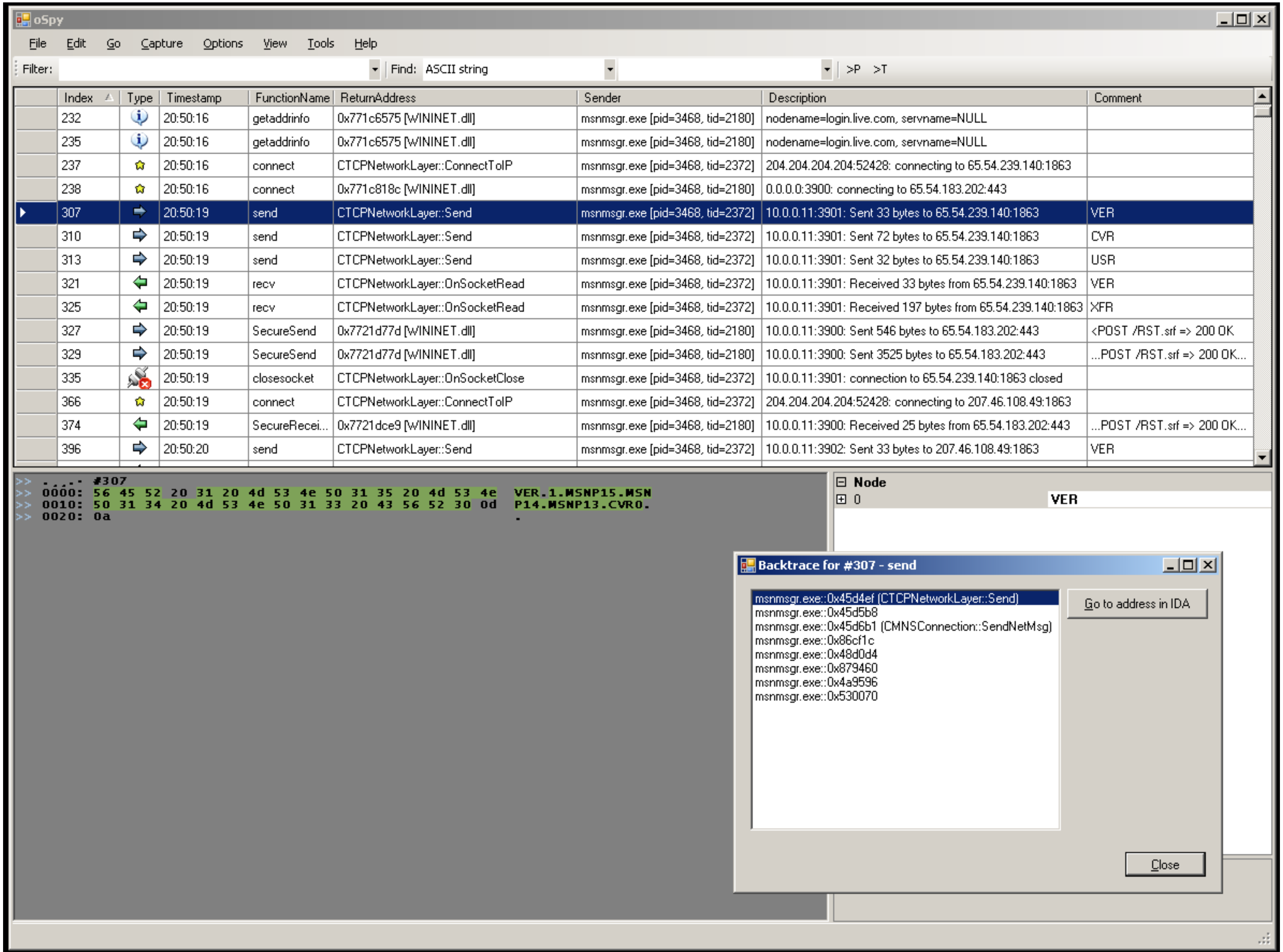

Debugger
Debuggee
bootstrapper-thread
bootstrapper
frida-agent.so


Debugger
Debuggee
bootstrapper-thread
bootstrapper
frida-agent.so
Comm. Channel


Debugger
Debuggee
bootstrapper-thread
bootstrapper
Comm. Channel
frida-agent.so
JavaScript

Motivation

- Existing tools often not a good fit for the task at hand
- Creating a new tool usually takes too much effort
- Short feedback loop: reversing is an iterative process
- Use one toolkit for multi-platform instrumentation
- Future remake of oSpy (see below)



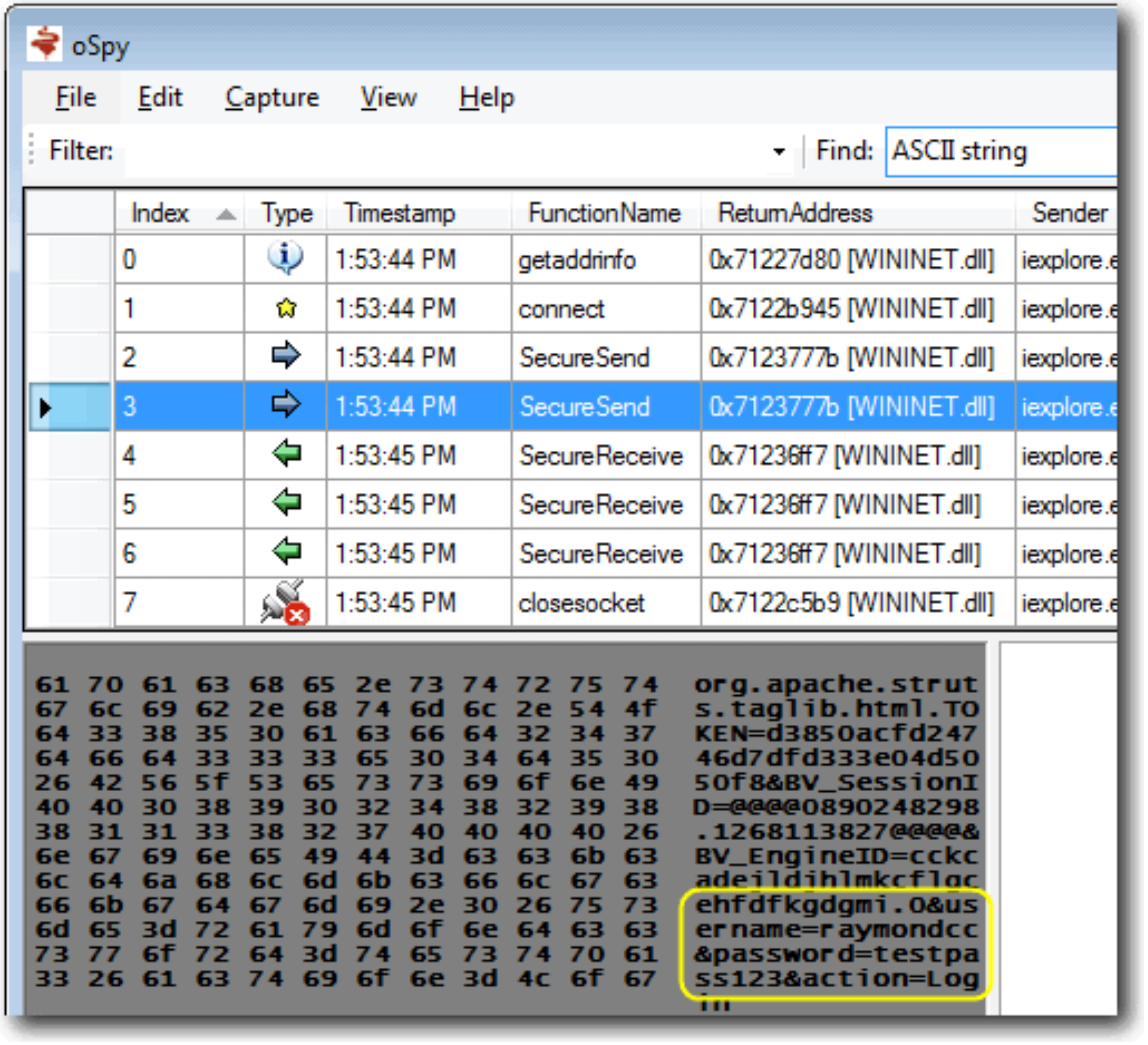
Index	Type	Timestamp	FunctionName	ReturnAddress	Sender	Description	Comment
232	ℹ	20:50:16	getaddrinfo	0x771c6575 [WININET.dll]	msnmsgr.exe [pid=3468, tid=2180]	nodename=login.live.com, servname=NULL	
235	ℹ	20:50:16	getaddrinfo	0x771c6575 [WININET.dll]	msnmsgr.exe [pid=3468, tid=2180]	nodename=login.live.com, servname=NULL	
237	☆	20:50:16	connect	CTCPNetworkLayer::ConnectToIP	msnmsgr.exe [pid=3468, tid=2372]	204.204.204.204:52428: connecting to 65.54.239.140:1863	
238	☆	20:50:16	connect	0x771c818c [WININET.dll]	msnmsgr.exe [pid=3468, tid=2180]	0.0.0.0:3900: connecting to 65.54.183.202:443	
307	➡	20:50:19	send	CTCPNetworkLayer::Send	msnmsgr.exe [pid=3468, tid=2372]	10.0.0.11:3901: Sent 33 bytes to 65.54.239.140:1863	VER
310	➡	20:50:19	send	CTCPNetworkLayer::Send	msnmsgr.exe [pid=3468, tid=2372]	10.0.0.11:3901: Sent 72 bytes to 65.54.239.140:1863	CVR
313	➡	20:50:19	send	CTCPNetworkLayer::Send	msnmsgr.exe [pid=3468, tid=2372]	10.0.0.11:3901: Sent 32 bytes to 65.54.239.140:1863	USR
321	⬅	20:50:19	recv	CTCPNetworkLayer::OnSocketRead	msnmsgr.exe [pid=3468, tid=2372]	10.0.0.11:3901: Received 33 bytes from 65.54.239.140:1863	VER
325	⬅	20:50:19	recv	CTCPNetworkLayer::OnSocketRead	msnmsgr.exe [pid=3468, tid=2372]	10.0.0.11:3901: Received 197 bytes from 65.54.239.140:1863	XFR
327	➡	20:50:19	SecureSend	0x7721d77d [WININET.dll]	msnmsgr.exe [pid=3468, tid=2180]	10.0.0.11:3900: Sent 546 bytes to 65.54.183.202:443	<POST /RST.srf => 200 OK
329	➡	20:50:19	SecureSend	0x7721d77d [WININET.dll]	msnmsgr.exe [pid=3468, tid=2180]	10.0.0.11:3900: Sent 3525 bytes to 65.54.183.202:443	...POST /RST.srf => 200 OK...
335	✖	20:50:19	closesocket	CTCPNetworkLayer::OnSocketClose	msnmsgr.exe [pid=3468, tid=2372]	10.0.0.11:3901: connection to 65.54.239.140:1863 closed	
366	☆	20:50:19	connect	CTCPNetworkLayer::ConnectToIP	msnmsgr.exe [pid=3468, tid=2372]	204.204.204.204:52428: connecting to 207.46.108.49:1863	
374	⬅	20:50:19	SecureRecei...	0x7721dce9 [WININET.dll]	msnmsgr.exe [pid=3468, tid=2180]	10.0.0.11:3900: Received 25 bytes from 65.54.183.202:443	...POST /RST.srf => 200 OK...
396	➡	20:50:20	send	CTCPNetworkLayer::Send	msnmsgr.exe [pid=3468, tid=2372]	10.0.0.11:3902: Sent 33 bytes to 207.46.108.49:1863	VER

```
>>  ....· #307
>>  0000: 56 45 52 20 31 20 4d 53 4e 50 31 35 20 4d 53 4e   VER.1.MSNP15.MSN
>>  0010: 50 31 34 20 4d 53 4e 50 31 33 20 43 56 52 30 0d   P14.MSNP13.CVR0.
>>  0020: 0a                                                .
```

Node
0 VER

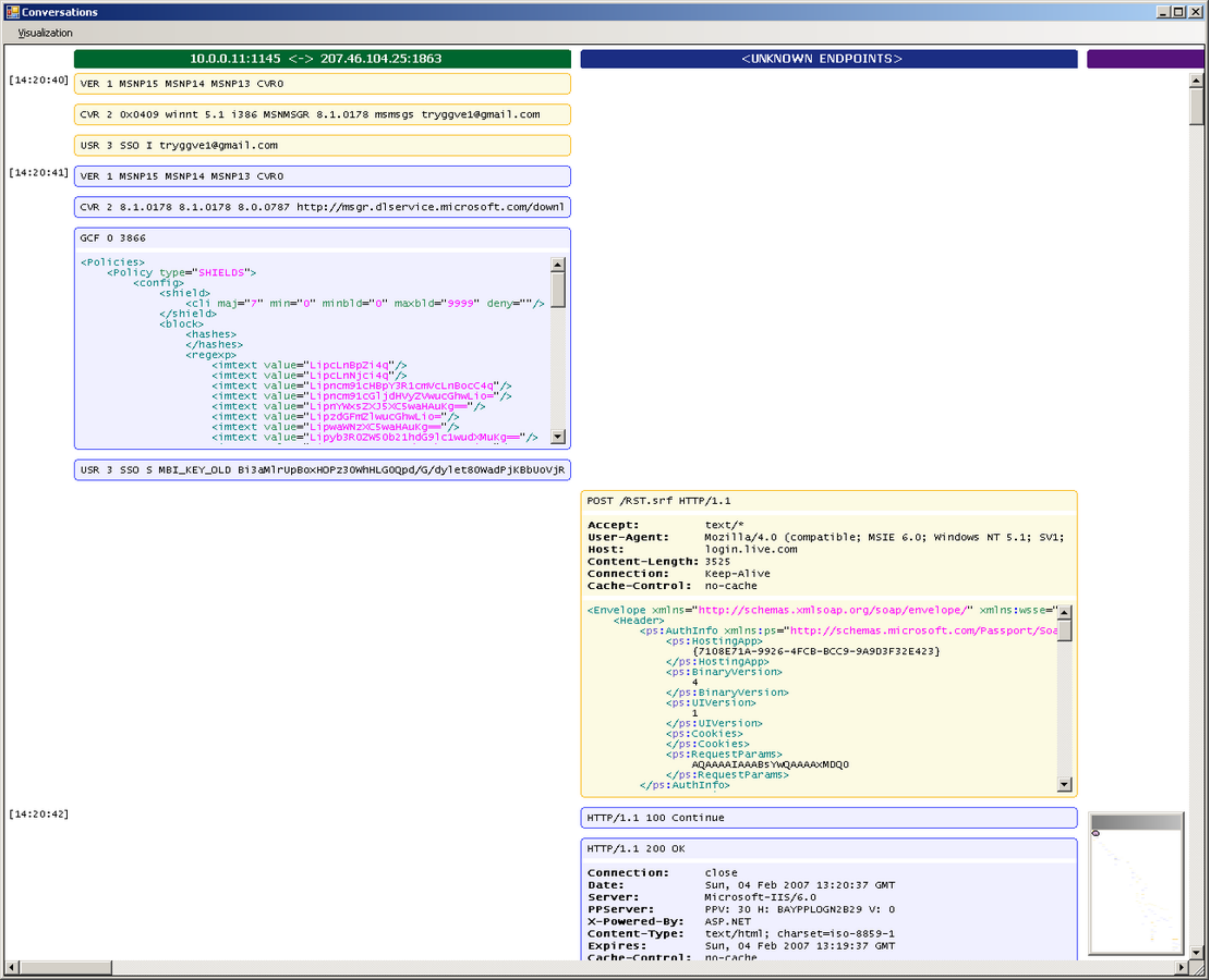
Backtrace for #307 - send

```
msnmsgr.exe::0x45d4ef (CTCPNetworkLayer::Send)
msnmsgr.exe::0x45d5b8
msnmsgr.exe::0x45d6b1 (CMNSConnection::SendNetMsg)
msnmsgr.exe::0x86cf1c
msnmsgr.exe::0x48d0d4
msnmsgr.exe::0x879460
msnmsgr.exe::0x4a9596
msnmsgr.exe::0x530070
```



Index	Type	Timestamp	FunctionName	ReturnAddress	Sender
0	ℹ	1:53:44 PM	getaddrinfo	0x71227d80 [WININET.dll]	iexplore.e
1	☆	1:53:44 PM	connect	0x7122b945 [WININET.dll]	iexplore.e
2	⇨	1:53:44 PM	SecureSend	0x7123777b [WININET.dll]	iexplore.e
3	⇨	1:53:44 PM	SecureSend	0x7123777b [WININET.dll]	iexplore.e
4	⇦	1:53:45 PM	SecureReceive	0x71236ff7 [WININET.dll]	iexplore.e
5	⇦	1:53:45 PM	SecureReceive	0x71236ff7 [WININET.dll]	iexplore.e
6	⇦	1:53:45 PM	SecureReceive	0x71236ff7 [WININET.dll]	iexplore.e
7	✖	1:53:45 PM	closesocket	0x7122c5b9 [WININET.dll]	iexplore.e

```
61 70 61 63 68 65 2e 73 74 72 75 74   org.apache.strut
67 6c 69 62 2e 68 74 6d 6c 2e 54 4f   s.taglib.html.TO
64 33 38 35 30 61 63 66 64 32 34 37   KEN=d3850acfd247
64 66 64 33 33 33 65 30 34 64 35 30   46d7dfd333e04d50
26 42 56 5f 53 65 73 73 69 6f 6e 49   50f8&BV_SessionI
40 40 30 38 39 30 32 34 38 32 39 38   D=@@@@0890248298
38 31 31 33 38 32 37 40 40 40 40 26   .1268113827@@@@&
6e 67 69 6e 65 49 44 3d 63 63 6b 63   BV_EngineID=cckc
6c 64 6a 68 6c 6d 6b 63 66 6c 67 63   adeildjhlmkcflgc
66 6b 67 64 67 6d 69 2e 30 26 75 73   ehfdfkgdgmi.0&us
6d 65 3d 72 61 79 6d 6f 6e 64 63 63   ername=raymondcc
73 77 6f 72 64 3d 74 65 73 74 70 61   &password=testpa
33 26 61 63 74 69 6f 6e 3d 4c 6f 67   ss123&action=Log
                                      in
```



```
[14:20:40]  VER 1 MSNP15 MSNP14 MSNP13 CVR0

            CVR 2 0x0409 winnt 5.1 i386 MSNMSGR 8.1.0178 msmsgs tryggve1@gmail.com

            USR 3 SSO I tryggve1@gmail.com

[14:20:41]  VER 1 MSNP15 MSNP14 MSNP13 CVR0

            CVR 2 8.1.0178 8.1.0178 8.0.0787 http://msgr.dlservice.microsoft.com/downl

            GCF 0 3866

            <Policies>
                <Policy type="SHIELDS">
                    <config>
                        <shield>
                            <cli maj="7" min="0" minbld="0" maxbld="9999" deny=""/>
                        </shield>
                        <block>
                            <hashes>
                            </hashes>
                            <regexp>
                                <imtext value="LipcLnBpZi4q"/>
                                <imtext value="LipcLnNjci4q"/>
                                <imtext value="Lipncm91cHBpY3R1cmVcLnBocC4q"/>
                                <imtext value="Lipncm91cGljdHVyZVwucGhwLio="/>
                                <imtext value="LipnYWxsZXJ5XC5waHAuKg=="/>
                                <imtext value="LipzdGFmZ1wucGhwLio="/>
                                <imtext value="LipwaWNzXC5waHAuKg=="/>
                                <imtext value="Lipyb3R0ZW50b21hdG9lc1wudXMuKg=="/>

            USR 3 SSO S MBI_KEY_OLD Bi3aMlrUpBoxHOPz30WhHLG0Qpd/G/dylet80WadPjKBbUoVjR
```

```
POST /RST.srf HTTP/1.1

Accept:         text/*
User-Agent:     Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1; SV1;
Host:           login.live.com
Content-Length: 3525
Connection:     Keep-Alive
Cache-Control:  no-cache

<Envelope xmlns="http://schemas.xmlsoap.org/soap/envelope/" xmlns:wsse="
    <Header>
        <ps:AuthInfo xmlns:ps="http://schemas.microsoft.com/Passport/Soa
            <ps:HostingApp>
                {7108E71A-9926-4FCB-BCC9-9A9D3F32E423}
            </ps:HostingApp>
            <ps:BinaryVersion>
                4
            </ps:BinaryVersion>
            <ps:UIVersion>
                1
            </ps:UIVersion>
            <ps:Cookies>
            </ps:Cookies>
            <ps:RequestParams>
                AQAAAAIAAABsYWQAAAAxMDQ0
            </ps:RequestParams>
        </ps:AuthInfo>
```

```
[14:20:42]

HTTP/1.1 100 Continue

HTTP/1.1 200 OK

Connection:     close
Date:           Sun, 04 Feb 2007 13:20:37 GMT
Server:         Microsoft-IIS/6.0
PPServer:       PPV: 30 H: BAYPPLOGN2B29 V: 0
X-Powered-By:   ASP.NET
Content-Type:   text/html; charset=iso-8859-1
Expires:        Sun, 04 Feb 2007 13:19:37 GMT
Cache-Control:  no-cache
```

What is Frida?

- Dynamic instrumentation toolkit
  - Debug live processes
- Scriptable
  - **Execute your own debug scripts inside another process**
- Multi-platform
  - Windows, Mac, Linux, iOS, Android, QNX
- Highly modular, JavaScript is optional
- Open Source

Why would you need Frida?

- For reverse-engineering
- For programmable debugging
- For dynamic instrumentation
- But ultimately: To enable rapid development of new tools for the task at hand

Let's explore the basics

▼

1) Build and run a simple program that calls f(**n**) every second with **n** increasing with each call.

2) Let's figure out what **n** is.

Frida has a REPL. Let's use it.

It live-reloads!

3) Let's modify what **n** is.

How about +9000?

4) Let's speed up time.

5) Let's call f() ourselves.

6) rpc, send() and recv().

Let's see what files Twitter open()s on macOS

Let's try interacting with Objective-C

Let's take that to iOS.

Let's figure out who is calling open().

Let's inspect registers.

Let's explore a bit with frida-trace on SnapChat.

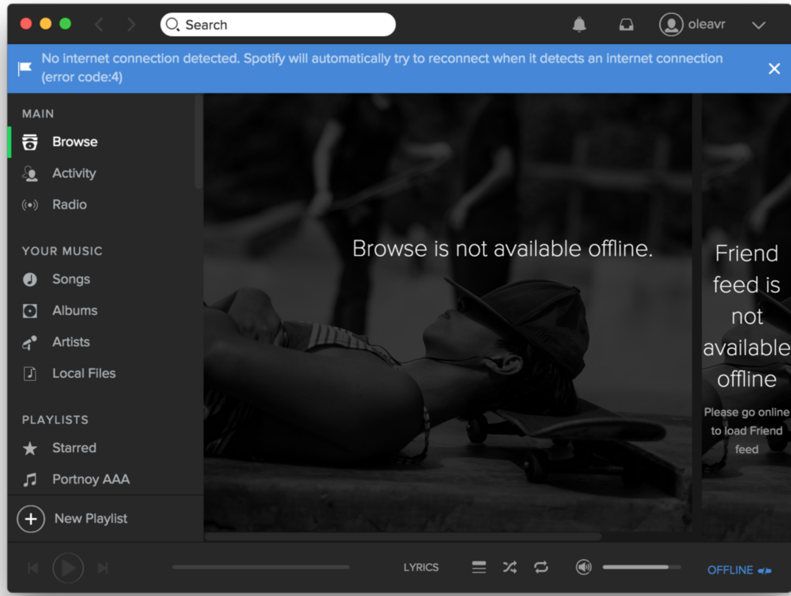
Android instrumentation

```
'use strict';

Java.perform(function () {
  var MainActivity = Java.use(
      're.frida.helloworld.MainActivity');
  MainActivity.isRegistered.implementation = function () {
    console.log('isRegistered() w00t');
    return true;
  };
});
```

Injecting errors

```javascript
'use strict';

const AF_INET = 2;
const AF_INET6 = 30;
const ECONNREFUSED = 61;

['connect', 'connect$NOCANCEL'].forEach(funcName => {
  const connect = new NativeFunction(
    Module.findExportByName('libsystem_kernel.dylib', funcName),
    'int',
    ['int', 'pointer', 'int']);
  Interceptor.replace(connect, new NativeCallback((socket, address, addressLen) => {
    const family = Memory.readU8(address.add(1));
    if (family == AF_INET || family == AF_INET6) {
      const port = (Memory.readU8(address.add(2)) << 8) | Memory.readU8(address.add(3));

      let ip = '';
      if (family == AF_INET) {
        for (let offset = 4; offset != 8; offset++) {
          if (ip.length > 0)
            ip += '.';
          ip += Memory.readU8(address.add(offset));
        }
      } else {
        for (let offset = 8; offset !== 24; offset += 2) {
          if (ip.length > 0)
            ip += ':';
          ip += toHex(Memory.readU8(address.add(offset))) +
              toHex(Memory.readU8(address.add(offset + 1)));
        }
      }

      console.log('connect() family=' + family + ' ip=' + ip + ' port=' + port);
      if (port === 80 || port === 443 || port === 4070) {
        console.log('  blocking!');
        this.errno = ECONNREFUSED;
        return -1;
      } else {
        console.log('  accepting!');
        return connect(socket, address, addressLen);
      }
    } else {
      return connect(socket, address, addressLen);
    }
  }, 'int', ['int', 'pointer', 'int']));

  send('ready');
});

function toHex(v) {
  let result = v.toString(16);
  if (result.length === 1)
    result = '0' + result;
  return result;
}
```

```
$ node app.js Spotify
connect() family=2 ip=78.31.9.101 port=80
  blocking!
connect() family=2 ip=193.182.7.242 port=80
  blocking!
connect() family=2 ip=194.132.162.4 port=443
  blocking!
connect() family=2 ip=194.132.162.4 port=80
  blocking!
connect() family=2 ip=194.132.162.212 port=80
  blocking!
connect() family=2 ip=194.132.162.196 port=4070
  blocking!
connect() family=2 ip=193.182.7.226 port=443
  blocking!
```



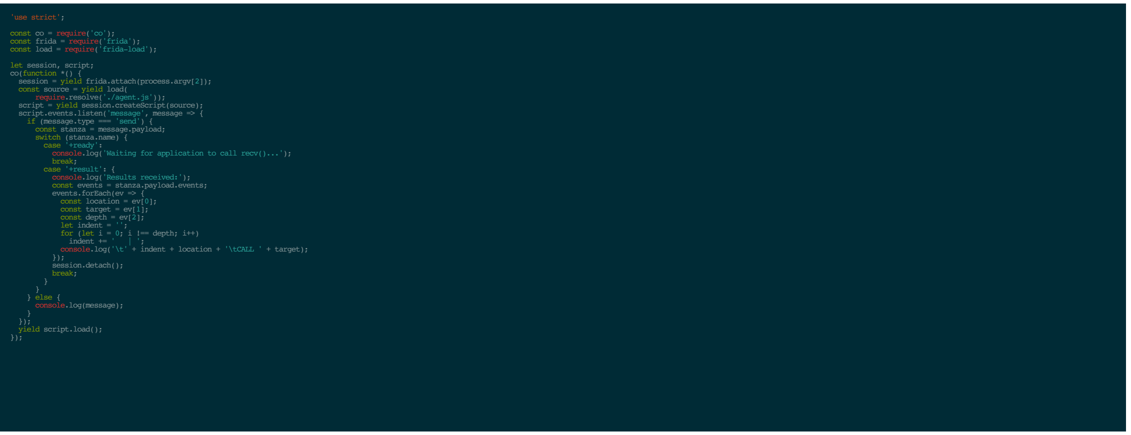
No internet connection detected. Spotify will automatically try to reconnect when it detects an internet connection (error code:4)

Browse is not available offline.

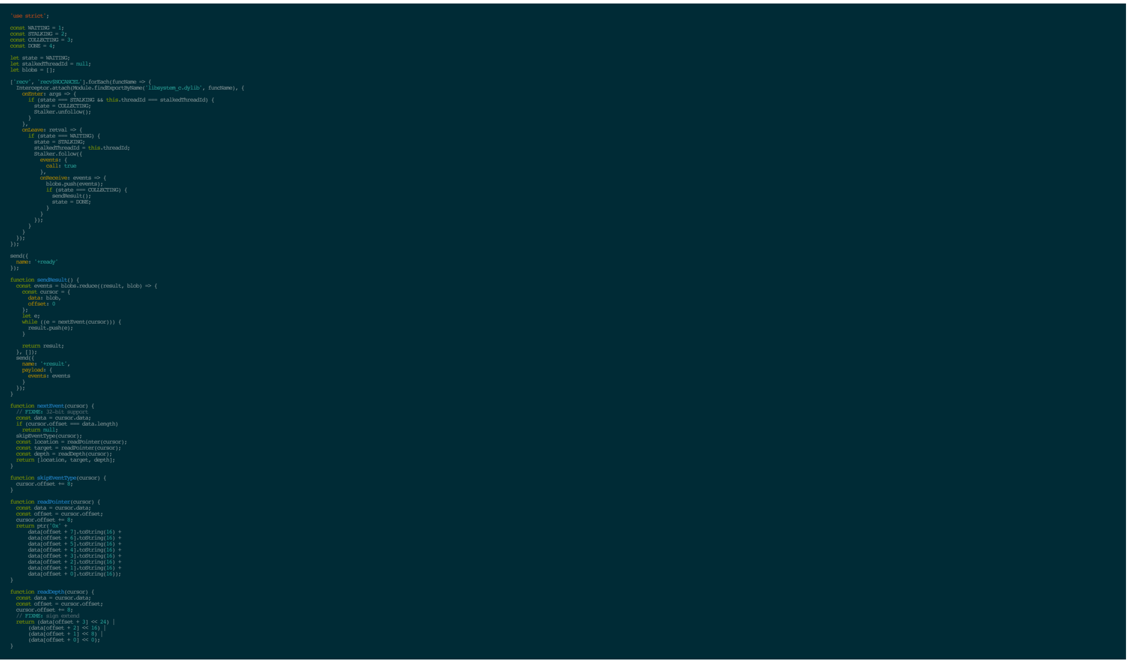
Friend feed is not available offline

Please go online to load Friend feed

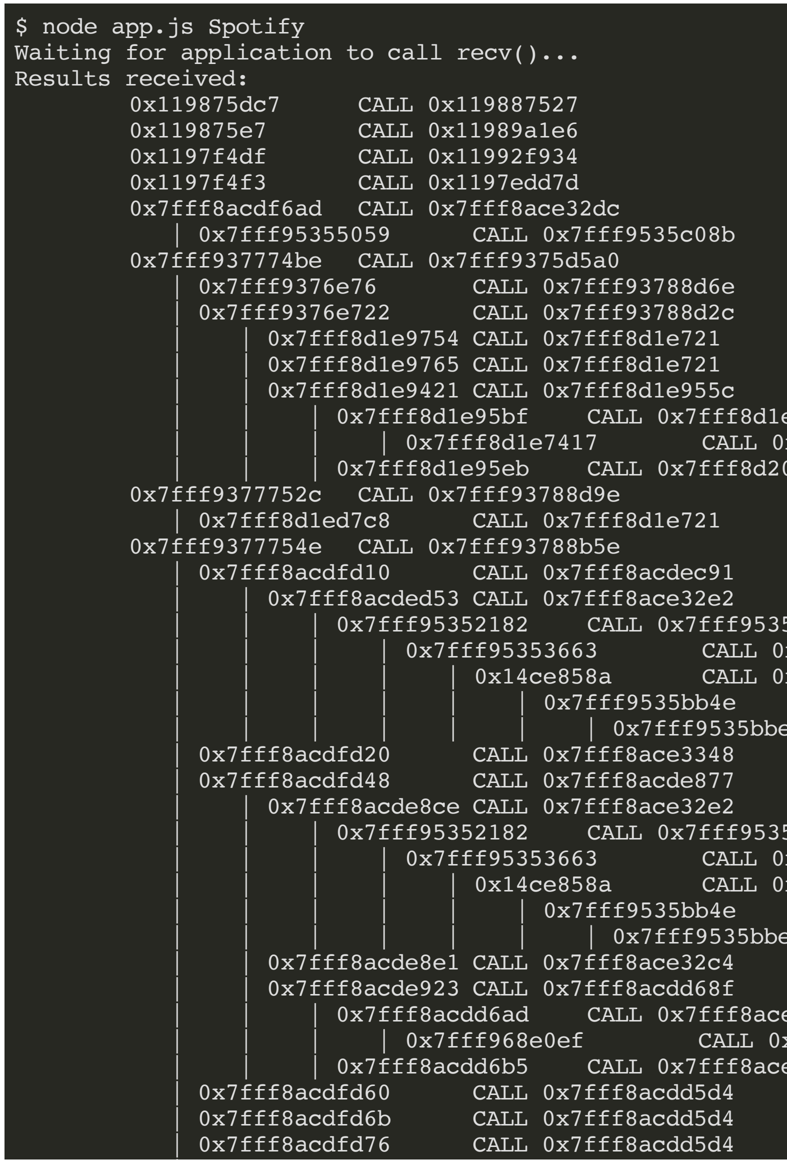
All calls between two recv() calls



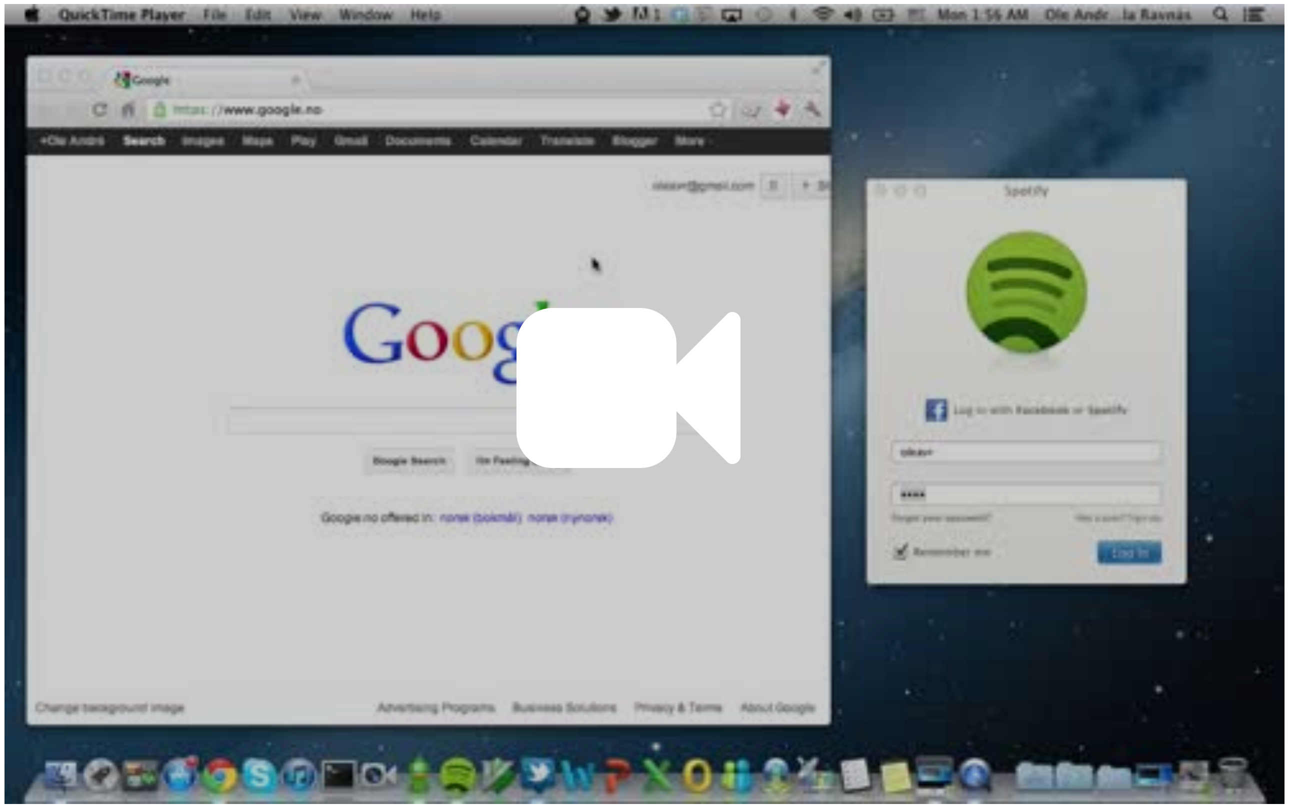
```javascript
'use strict';

const co = require('co');
const frida = require('frida');
const load = require('frida-load');

let session, script;
co(function *() {
  session = yield frida.attach(process.argv[2]);
  const source = yield load(
      require.resolve('./agent.js'));
  script = yield session.createScript(source);
  script.events.listen('message', message => {
    if (message.type === 'send') {
      const stanza = message.payload;
      switch (stanza.name) {
        case '+ready':
          console.log('Waiting for application to call recv()...');
          break;
        case '+result': {
          console.log('Results received:');
          const events = stanza.payload.events;
          events.forEach(ev => {
            const location = ev[0];
            const target = ev[1];
            const depth = ev[2];
            let indent = '';
            for (let i = 0; i !== depth; i++)
              indent += '   | ';
            console.log('\t' + indent + location + '\tCALL ' + target);
          });
          session.detach();
          break;
        }
      }
    } else {
      console.log(message);
    }
  });
  yield script.load();
});
```



```javascript
'use strict';

const WAITING = 1;
const STALKING = 2;
const COLLECTING = 3;
const DONE = 4;

let state = WAITING;
let stalkedThreadId = null;
let blobs = [];

['recv', 'recv$NOCANCEL'].forEach(funcName => {
  Interceptor.attach(Module.findExportByName('libsystem_c.dylib', funcName), {
    onEnter: args => {
      if (state === STALKING && this.threadId === stalkedThreadId) {
        state = COLLECTING;
        Stalker.unfollow();
      }
    },
    onLeave: retval => {
      if (state === WAITING) {
        state = STALKING;
        stalkedThreadId = this.threadId;
        Stalker.follow({
          events: {
            call: true
          },
          onReceive: events => {
            blobs.push(events);
            if (state === COLLECTING) {
              sendResult();
              state = DONE;
            }
          }
        });
      }
    }
  });
});

send({
  name: '+ready'
});

function sendResult() {
  const events = blobs.reduce((result, blob) => {
    const cursor = {
      data: blob,
      offset: 0
    };
    let e;
    while ((e = nextEvent(cursor))) {
      result.push(e);
    }

    return result;
  }, []);
  send({
    name: '+result',
    payload: {
      events: events
    }
  });
}

function nextEvent(cursor) {
  // FIXME: 32-bit support
  const data = cursor.data;
  if (cursor.offset === data.length)
    return null;
  skipEventType(cursor);
  const location = readPointer(cursor);
  const target = readPointer(cursor);
  const depth = readDepth(cursor);
  return [location, target, depth];
}

function skipEventType(cursor) {
  cursor.offset += 8;
}

function readPointer(cursor) {
  const data = cursor.data;
  const offset = cursor.offset;
  cursor.offset += 8;
  return ptr('0x' +
      data[offset + 7].toString(16) +
      data[offset + 6].toString(16) +
      data[offset + 5].toString(16) +
      data[offset + 4].toString(16) +
      data[offset + 3].toString(16) +
      data[offset + 2].toString(16) +
      data[offset + 1].toString(16) +
      data[offset + 0].toString(16));
}

function readDepth(cursor) {
  const data = cursor.data;
  const offset = cursor.offset;
  cursor.offset += 8;
  // FIXME: sign extend
  return (data[offset + 3] << 24) |
      (data[offset + 2] << 16) |
      (data[offset + 1] << 8) |
      (data[offset + 0] << 0);
}
```



```
$ node app.js Spotify
Waiting for application to call recv()...
Results received:
        0x119875dc7     CALL 0x119887527
        0x119875e7      CALL 0x11989a1e6
        0x1197f4df      CALL 0x11992f934
        0x1197f4f3      CALL 0x1197edd7d
        0x7fff8acdf6ad  CALL 0x7fff8ace32dc
           | 0x7fff95355059     CALL 0x7fff9535c08b
        0x7fff937774be  CALL 0x7fff9375d5a0
           | 0x7fff9376e76      CALL 0x7fff93788d6e
           | 0x7fff9376e722     CALL 0x7fff93788d2c
           |    | 0x7fff8d1e9754 CALL 0x7fff8d1e721
           |    | 0x7fff8d1e9765 CALL 0x7fff8d1e721
           |    | 0x7fff8d1e9421 CALL 0x7fff8d1e955c
           |    |    | 0x7fff8d1e95bf    CALL 0x7fff8d1e
           |    |    |    | 0x7fff8d1e7417        CALL 0
           |    |    | 0x7fff8d1e95eb    CALL 0x7fff8d2
        0x7fff9377752c  CALL 0x7fff93788d9e
           | 0x7fff8d1ed7c8     CALL 0x7fff8d1e721
        0x7fff9377754e  CALL 0x7fff93788b5e
           | 0x7fff8acdfd10     CALL 0x7fff8acdec91
           |    | 0x7fff8acded53 CALL 0x7fff8ace32e2
           |    |    | 0x7fff95352182    CALL 0x7fff9535
           |    |    |    | 0x7fff95353663        CALL 0
           |    |    |    |    | 0x14ce858a        CALL 0
           |    |    |    |    |    | 0x7fff9535bb4e
           |    |    |    |    |    |    | 0x7fff9535bbe
           | 0x7fff8acdfd20     CALL 0x7fff8ace3348
           | 0x7fff8acdfd48     CALL 0x7fff8acde877
           |    | 0x7fff8acde8ce CALL 0x7fff8ace32e2
           |    |    | 0x7fff95352182    CALL 0x7fff9535
           |    |    |    | 0x7fff95353663        CALL 0
           |    |    |    |    | 0x14ce858a        CALL 0
           |    |    |    |    |    | 0x7fff9535bb4e
           |    |    |    |    |    |    | 0x7fff9535bbe
           |    | 0x7fff8acde8e1 CALL 0x7fff8ace32c4
           |    | 0x7fff8acde923 CALL 0x7fff8acdd68f
           |    |    | 0x7fff8acdd6ad    CALL 0x7fff8ace
           |    |    |    | 0x7fff968e0ef        CALL 0x
           |    |    | 0x7fff8acdd6b5    CALL 0x7fff8ace
           | 0x7fff8acdfd60     CALL 0x7fff8acdd5d4
           | 0x7fff8acdfd6b     CALL 0x7fff8acdd5d4
           | 0x7fff8acdfd76     CALL 0x7fff8acdd5d4
```


QuickTime Player
File
Edit
View
Window
Help
Mon 1:56 AM
https://www.google.no
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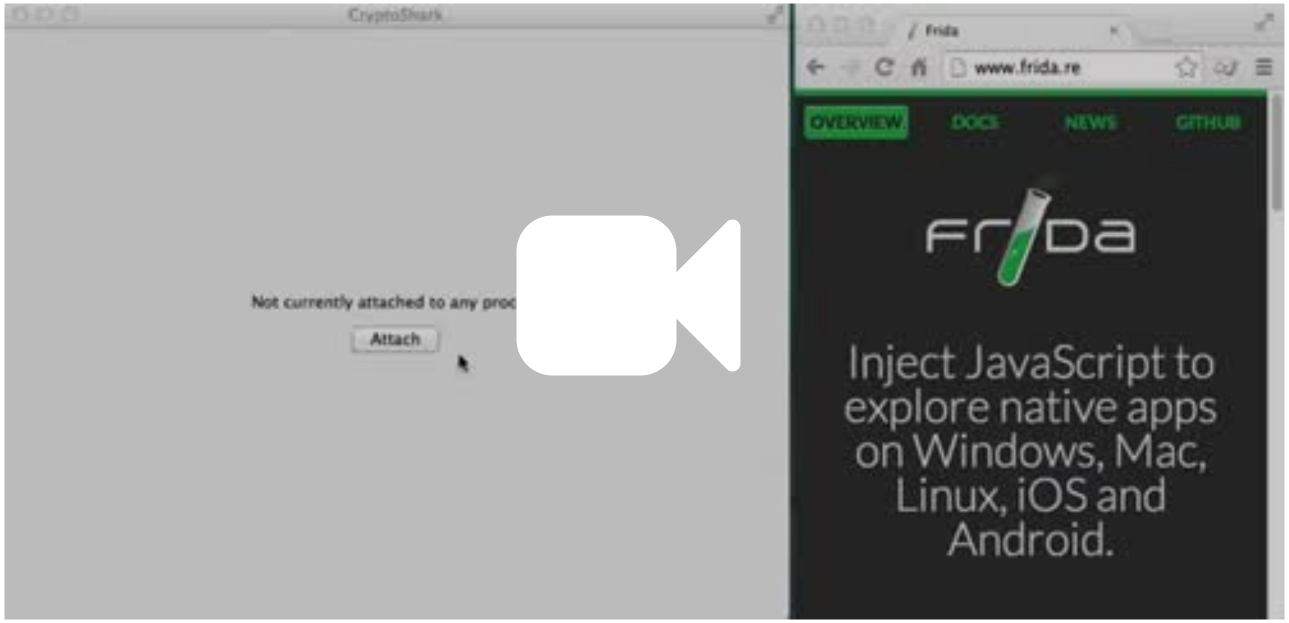
CryptoShark
Not currently attached to any proc
Attach
Frida
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FRIDA
Inject JavaScript to explore native apps on Windows, Mac, Linux, iOS and Android.

Questions?

Twitter: @oleavr @fridadotre

Thanks!

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