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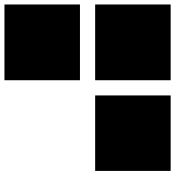
DIGITAL SECURITY



How to develop an unpacker

The StarForce case

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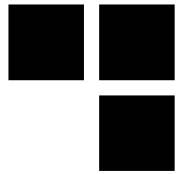
Whoami

- **Eloi Vanderbeken IRL**
- **@elvanderb on twitter**

- **Working for Synacktiv:**
  - Offensive security company (pentest, red team, vuln hunting, exploitation etc.)
  - If there is software in it, we can own it :)
  - We are recruiting!

Packers



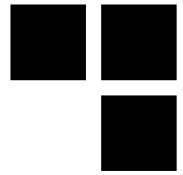
- **Several types of packers**
  - Malware packers: often very simple, just used to bypass AV
  - Compressor: also very simple, just used to reduce binaries size (UPX)
  - Protectors: need to resist to skilled reversers / crackers
- **Protectors**
  - Wrap an existing program into another one
  - Offer APIs to interact with the packer (licensing, protected variables etc.)
  - New program is harder to study (Anti-X, virtualization, etc.)
  - The protection should not be easy to remove → protection and original program must be entangled

Offensive information security?

Yes!

- **Some vuln^winteresting programs are protected by protectors**
- **You won't be able to reverse or fuzz them without unpacking them**
- **Unpacking is the sum of numerous useful skills for a vuln hunter**
  - reversing, automation, Windows internals, PE format, etc.
- **It's fun, you fight against someone trying to block you**

Our target: StarForce

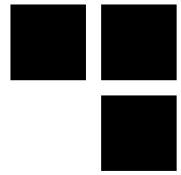


- **What we won't cover: StarForce Disc**
  - Infamous protection used in 2000-2007
  - Used a ring0 driver and virtualization
  - Resisted to crackers for 420 days (!!!)

- **What we'll see: StarForce ProActive**
  - Lighter protection (no r0, no VM)
  - Includes licensing tools
  - Used to protect a lot of Shareware
  - A lot simpler than the older one but still interesting :)

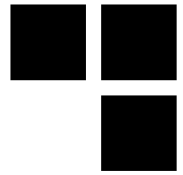
Our unpacker: Astroboon

Architecture of our unpacker



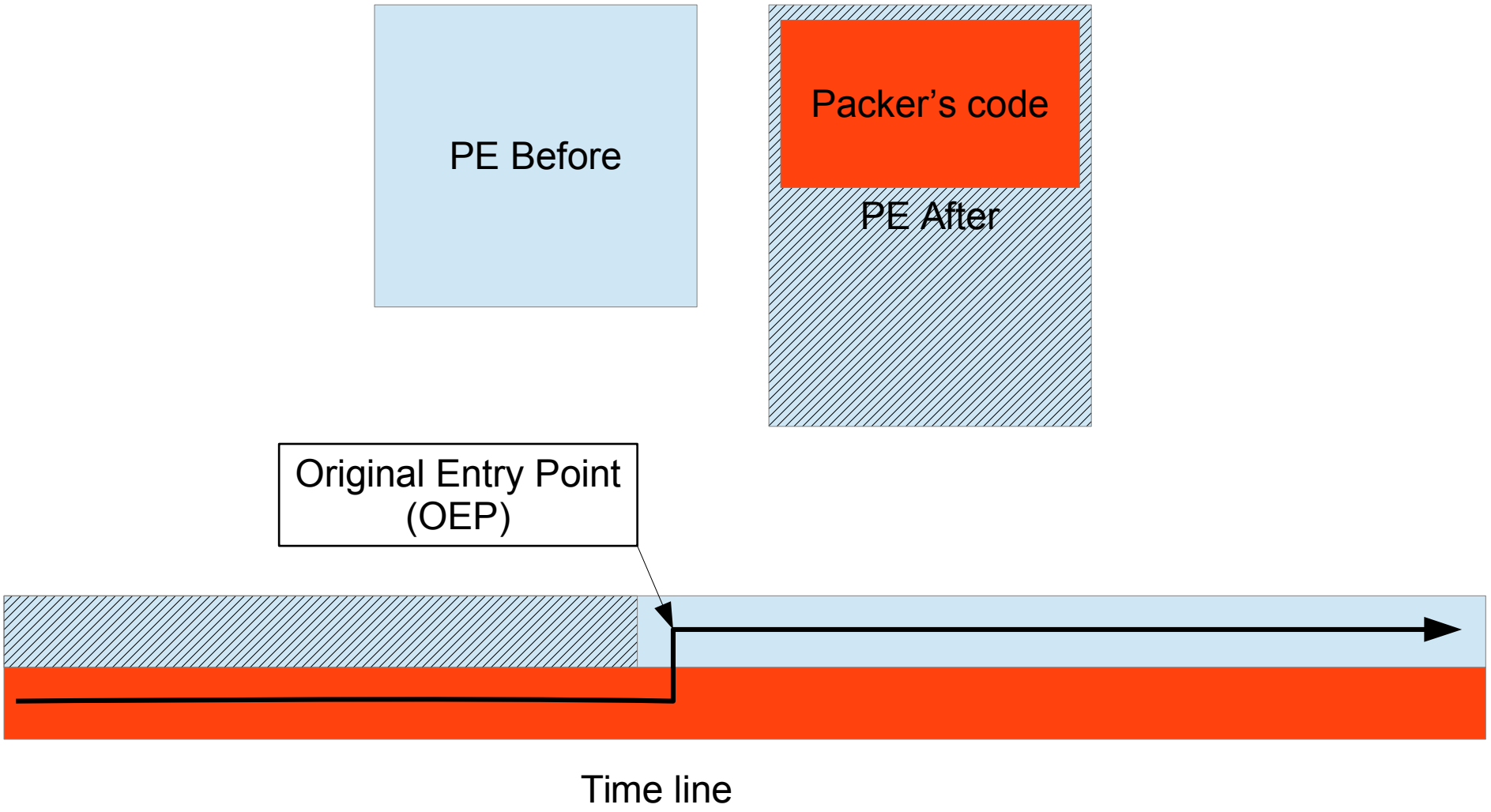
- **DLL injected in the targeted process**
  - No debug API
  - No memory translation needed
  - Direct access to several information (PEB, registers)
- **Coded in C**
  - And some inlined ASM
  - 1200 lines of StarForce specific code
- **(Almost) no external dependencies**
  - It uses BeatriX LDE but it also includes my own disassembler so I could drop the LDE
  - Includes a PE parser, a PE dumper, an import fixer, a code hooker, a disassembler, etc

Organisation of the slides

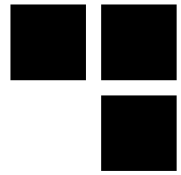


- **For each protection**
  - Description of the protection
  - Description on how it's implemented by various protectors
  - How to bypass it in the StarForce case
  - How to implement the automatic bypass in our unpacker
- **At each step, if you have any question, please ask :)**

Part 1: layers

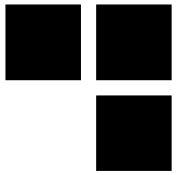


Layers: what we need to do



- **Find the OEP**
  - Signatures of common RT entry points
  - Hooks on APIs commonly used at the entry point (GetCommandLine)
  - Examination of the call stack and code xrefs
  - etc.
- **Dump the process**
  - LordPE / ImpRec (a little bit outdated now ☺)
  - Scylla (open source !)
  - BaDu (Baboon's Dumper (yes, I know))

Layers: How to automatically find the OEP



- **Change pages rights**
  - Remove the eXecution right
- **Make sure they are not restored**
  - Hook VirtualProtect
- **Catch the exceptions**
  - We use Vectored Exception Handlers
  - We could put a hook on KiUserExceptionDispatcher…
  - … but some packers will detect this
- **When the process tries to execute one of the first sections: we are at the OEP**

Layers: How to automatically find the OEP

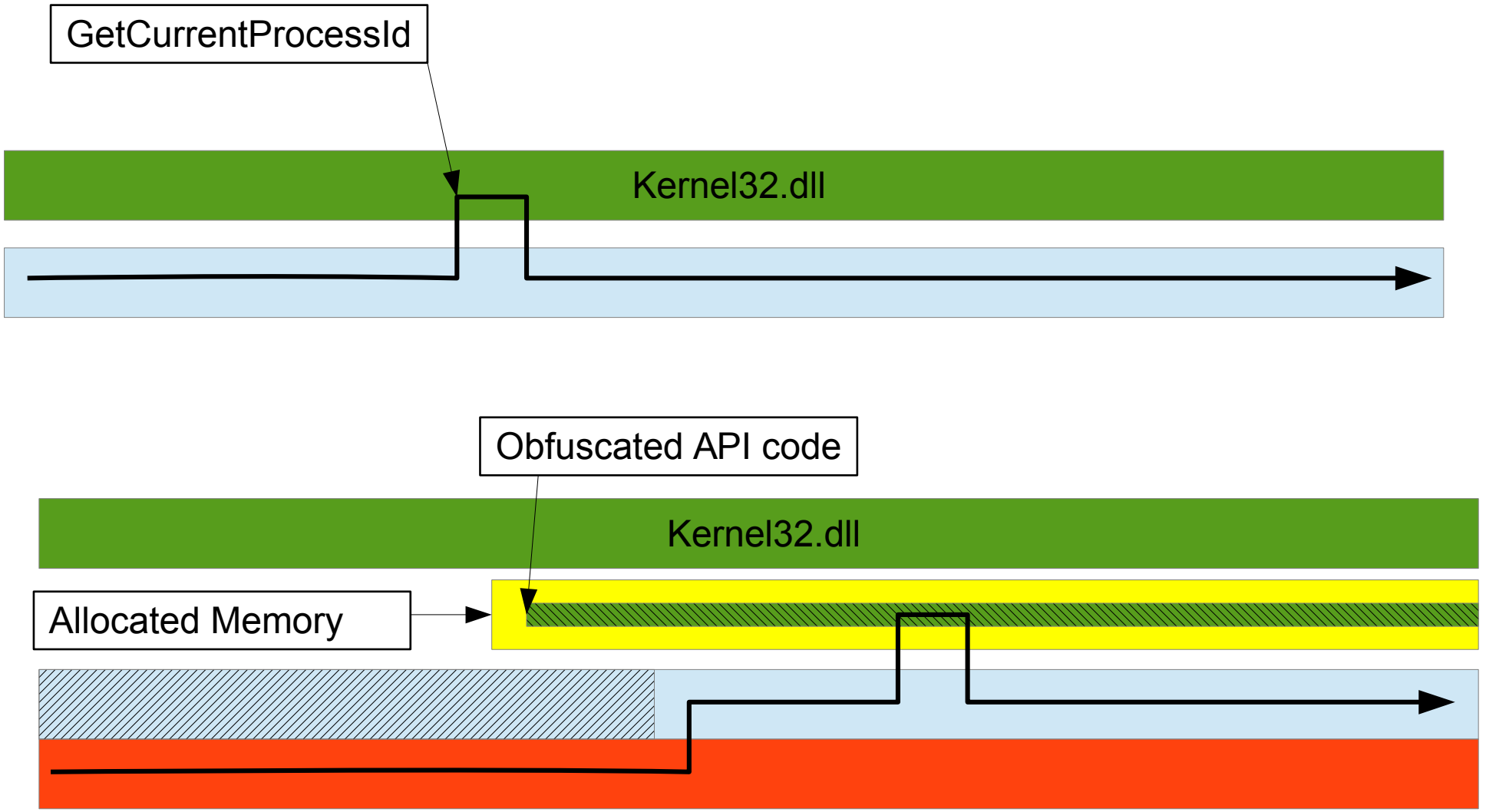
```
VirtualProtectAddr = (PBYTE)GetProcAddress(GetModuleHandleA("Kernel32"), "VirtualProtect");
hookFun(VirtualProtectAddr, (PBYTE)HookedVirtualProtect, (FARPROC*)&OrigVirtualProtect);
vectoredHandler = AddVectoredExceptionHandler(0,ProtectionFaultVectoredHandler);
```

```
LONG CALLBACK ProtectionFaultVectoredHandler(PEXCEPTION_POINTERS ExceptionInfo)
{
    if (ExceptionInfo->ExceptionRecord->ExceptionCode == STATUS_GUARD_PAGE_VIOLATION)
    {
        DWORD address = ExceptionInfo->ExceptionRecord->ExceptionInformation[1];
        DWORD eip = ExceptionInfo->ContextRecord->Eip;
        DWORD oldProtect;

        OrigVirtualProtect((PBYTE)textaddress, textsize, PAGE_EXECUTE_READWRITE, &oldProtect);

        if ((eip == address) && (address >= (DWORD)textaddress) && (address < (DWORD)textaddress+textsize))
        {
            MessageBoxA(0, "OEP LOL", "OEP LOL",0);
            Dump(...);
        }
        return EXCEPTION_CONTINUE_EXECUTION;
    }
    return EXCEPTION_CONTINUE_SEARCH;
}
```

Part 2: API redirection



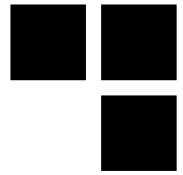
API Redir: what we need to do

- **Find the IAT**
  - Find all the call [XXX] / jmp [XXX]
  - Search for API addresses above and between the min and max addresses
- **Fix redirections**
  - Very protector specific, different kind of redirections
  - Some of them includes special protections in them (SecuROM triggers)
- **Two main approaches:**
  - Hook the redirection mechanism

    We will have the real API addresses...

    But need to find the redirection mechanism (signatures, heuristics etc.)
  - Try to recover the original API address from the redirection
- **Once the original addresses are recovered, rebuild the IAT**
  - ImpRec / ChimpREC (a little bit outdated)
  - Scylla
  - BINI: BINI Is Not ImpRec (No *Baboon* in this name!)

API Redir: StarForce case



- **Addresses in the IAT point to obfuscated version of the original API**
  - No direct redirection in the code (call [API addr] replaced by call REDIRECTION for example)
  - No destruction of the IAT (all the addresses are at their original place)
- **Obfuscated version is created on the fly**
  - Even the API with known behavior (GetCurrentProcessId, GetCurrentProcess, GetProcessHeap, etc.)
- **Sometimes the entire API is rewritten**
  - no final jump to the original code to help us
- **~ 20 obfuscation rules**
  - cmc / cmc = nop
  - push X / xchg [esp], Y = push Y
  - etc.

Astroboon approach

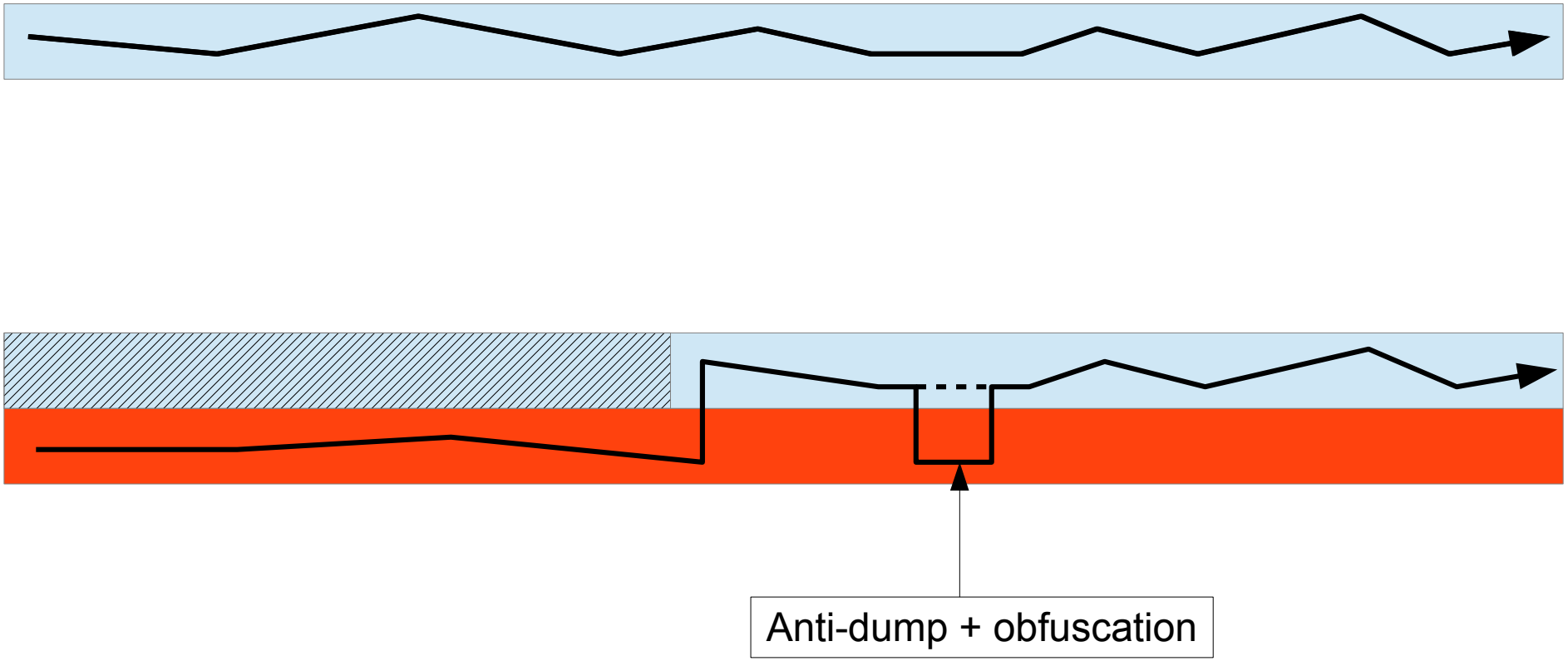
- **Construct a canonical representation**
  - Disassemble the code
  - Stop when we encounter a RET
  - Follow the unconditional JMPs, not the JCC
  - Don’t enter the calls
  - Deobfuscate the produced trace
- **If the canonical representation of an obfuscated code matches the one of an API → WIN**
- **But we can have multiple matches in multiple DLLs**
  - We can use adjacent addresses to solve this problem
  - Adjacent addresses → same DLL

Astroboon approach - cont'd

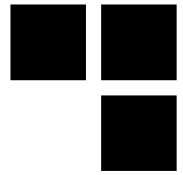
```
XCHG R32a , R32b
PUSH R32b
XCHG R32a , R32b
=
PUSH R32a
```

```
else if ((i+2 < length) &&
        (StrctInsCmp(&instructions[i],&xchg)) &&
        (StrctInsCmp(&instructions[i+1],&push)) &&
        (StrctInsCmp(&instructions[i+2],&xchg)) &&
        (ArgCmp(TYPE_REG,&instructions[i].Arg1,&instructions[i+2].Arg1)) &&
        (ArgCmp(TYPE_REG,&instructions[i].Arg2,&instructions[i+1].Arg1)) &&
        (ArgCmp(TYPE_REG,&instructions[i].Arg2,&instructions[i+2].Arg2)))
{
    retins[j].instruction = INS_PUSH;
    retins[j].ArgT1 = instructions[i].ArgT1;
    retins[j].PG1 = retins[j].PG2 = retins[j].PG3 = retins[j].PG4 = 0;
    CopyMemory(&retins[j].Arg1,&instructions[i].Arg1,sizeof(ARG));
    retins[j].ArgT2 = 0;
    i+=2;
    j++;
}
```

Part 3: Code redirection

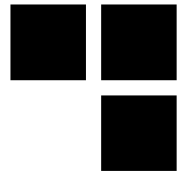


Code redirections: how to fix this



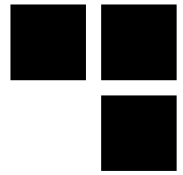
- **Find all the redirections**
  - Find all the call / jmp / jcc instructions which point to the StarForce section
- **Fix the redirections**
  - Depends on the protector
  - Often based on tracing methods

Astroboon approach



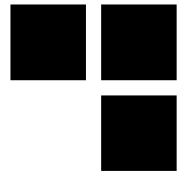
- **A code is always used a little bit before jumping to the original code**
- **It doesn't change between versions**
  - Easy to put a sig on it
  - pop eax / popfd / pop ebp / lea esp,[esp+4] / pop edi / pop esi / pop edx / pop ecx / pop ebx / xchg [esp],eax / retn
- **All we have to do is set a HBP on it, jump on the redirection and let StarForce do the redirection for us.**
  - Modify debug registers with SetThreadContext
  - Make sure our HBP cannot be detected with a SEH by clearing the DRs in our VEH and restoring them via a hook on ZwContinue
- **To find the final jump we trace the code step by step by setting the Trap Flag**
  - To make sure it's not detected/cleared with a PUSHFD/POPFD, we clear/set the Trap Flag in the stack when we detect those instructions after/before their execution.

Part 4: StarForce MISC



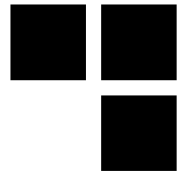
- **StarForce tries to detect VMs**
  - Under VirtualBox, just clear the registry key HKLM\HARDWARE\DESCRIPTION\System\VideoBiosVersion
- **StarForce has a watchdog thread that detects debuggers and patches**
  - Just kill it before starting to reconstruct the executable
- **StarForce uses the (non-reversible) ThreadHideFromDebugger thread information class to… hide threads from the debugger**
  - Hook NtSetInformationThread and block the calls

Part 5: MISC MISC



- **When your reconstruction code fails for unknown reason, try to add delays or random**
  - Some protectors detect when you call all the redirected function one after the other
- **Always prefer HBP over BP**
- **Prefer generic methods over signatures**
  - But use signatures when it's handy :D
- **To attach your debugger to a protected process**
  - Patch NtSetInformationThread before running it → bypass ThreadHideFromDebugger
  - Suspend the process → watchdog threads will be neutralized
  - In your debugger, patch DebugActiveProcess to make sure that DbgUiIssueRemoteBreakin is not called → no thread will be created in the debugged process

Part 6: to go further...



- **Armadillo**
  - API redirection / IAT destruction
  - Nanomite
  - CopyMEM2
- **SecuROM**
  - Triggers
- **ASProtect**
  - Now owned by StarForce :D
  - IAT destruction, custom VM, custom anti dumps
- **Themida**
  - VM, anti X
- **VMProtect**
  - VM...

Do you have any questions?

THANK YOU FOR YOUR ATTENTION

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