REVERSE ENGINEERING

SRE

- Software Reverse Engineering
  - Also known as Reverse Code Engineering (RCE)
  - Or simply "reversing"
- Can be used for good…
  - Understand malware
  - Understand legacy code
- …or not-so-good
  - Remove usage restrictions from software
  - Find and exploit flaws in software
  - Cheat at games, etc.

SRE

- We assume that
  - Reverse engineer is an attacker
  - Attacker only has exe (no source code)
- Attacker might want to
  - Understand the software
  - Modify the software
- SRE usually focused on Windows
- So we'll focus on Windows

SRE TOOLS

- Disassembler
  - Converts exe to assembly — as best it can
  - Cannot always disassemble correctly
  - In general, it is not possible to assemble disassembly into working exe
- Debugger
  - Must step through code to completely understand it
  - Labor intensive — lack of automated tools
- Hex Editor
  - To patch (make changes to) exe file
- Regmon, Filemon, VMware, etc.

SRE TOOLS

- IDA Pro is the top-rated disassembler
  - Cost is a few hundred dollars
  - Converts binary to assembly (as best it can)
- SoftICE is "alpha and omega" of debuggers
  - Cost is in the $1000's
  - Kernel mode debugger
  - Can debug anything, even the OS
- OllyDbg is a high quality shareware debugger
  - Includes a good disassembler
- Hex editor — to view/modify bits of exe
  - UltraEdit is good — freeware
  - HIEW — useful for patching exe
- Regmon, Filemon — freeware

WHY IS A DEBUGGER NEEDED?

- Disassembler gives static results
  - Good overview of program logic
  - But need to "mentally execute" program
  - Difficult to jump to specific place in the code
- Debugger is dynamic
  - Can set break points
  - Can treat complex code as "black box"
  - Not all code disassembles correctly
- Disassembler and debugger both required for any serious SRE task

SRE NECESSARY SKILLS

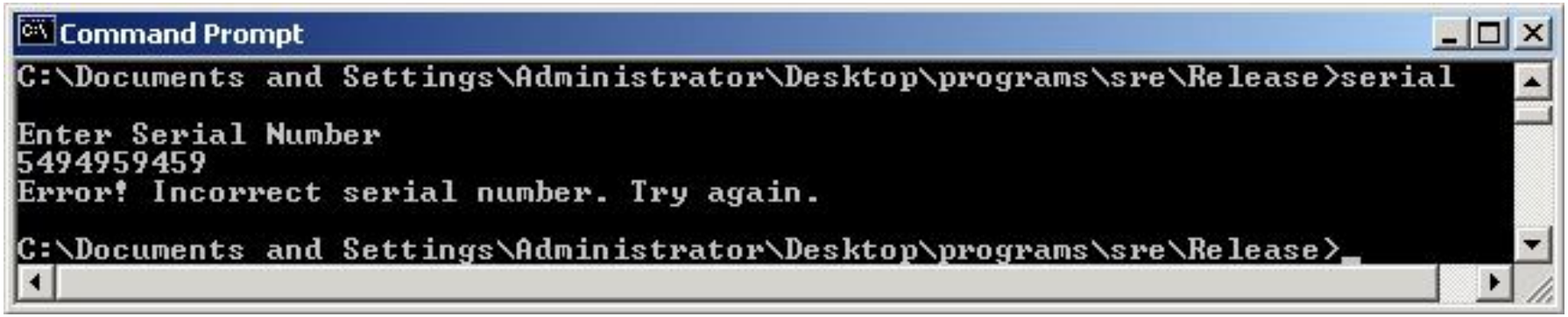
- Working knowledge of target assembly code
- Experience with the tools
  - IDA Pro — sophisticated and complex
  - SoftICE — large two-volume users manual
- Knowledge of Windows Portable Executable (PE) file format
- Boundless patience and optimism
- SRE is tedious and labor-intensive process!

SRE EXAMPLE

- Consider simple example
- This example only requires disassembler (IDA Pro) and hex editor
  - Disassemble to understand code
  - Want to patch the code
- For most real-world code, also need a debugger (SoftICE or OllyDbg)

SRE EXAMPLE

- Program requires serial number
- But User doesn't know the serial number!



Can you find the serial number?

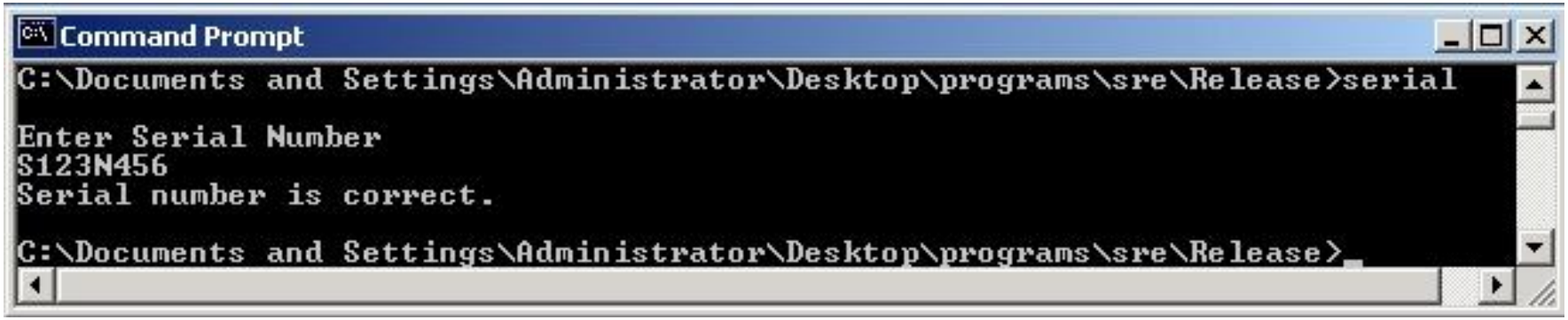
SRE EXAMPLE

```
.text:00401003                push    offset aEnterSerialNum ; "\nEnter Serial Number\n"
.text:00401008                call    sub_4010AF
.text:0040100D                lea     eax, [esp+18h+var_14]
.text:00401011                push    eax
.text:00401012                push    offset aS       ; "%s"
.text:00401017                call    sub_401098
.text:0040101C                push    8
.text:0040101E                lea     ecx, [esp+24h+var_14]
.text:00401022                push    offset aS123n456 ; "S123N456"
.text:00401027                push    ecx
.text:00401028                call    sub_401060
.text:0040102D                add     esp, 18h
.text:00401030                test    eax, eax
.text:00401032                jz      short loc_401045
.text:00401034                push    offset aErrorIncorrect ; "Error! Incorrect serial number.
.text:00401039                call    sub_4010AF
```

Looks like serial number is S123N456

SRE EXAMPLE

- Try the serial number S123N456



It works!

Can we do better?

SRE EXAMPLE

```
.text:00401003                push    offset aEnterSerialNum ; "\nEnter Serial Number\n"
.text:00401008                call    sub_4010AF
.text:0040100D                lea     eax, [esp+18h+var_14]
.text:00401011                push    eax
.text:00401012                push    offset aS       ; "%s"
.text:00401017                call    sub_401098
.text:0040101C                push    8
.text:0040101E                lea     ecx, [esp+24h+var_14]
.text:00401022                push    offset aS123n456 ; "S123N456"
.text:00401027                push    ecx
.text:00401028                call    sub_401060
.text:0040102D                add     esp, 18h
.text:00401030                test    eax, eax
.text:00401032                jz      short loc_401045
.text:00401034                push    offset aErrorIncorrect ; "Error! Incorrect serial number.
.text:00401039                call    sub_4010AF
```

And hex view…

```
.text:00401010  04 50 68 84 80 40 00 E8-7C 00 00 00 6A 08 8D 4C
.text:00401020  24 10 68 78 80 40 00 51-E8 33 00 00 00 83 C4 18
.text:00401030  85 C0 74 11 68 4C 80 40-00 E8 71 00 00 00 83 C4
.text:00401040  04 83 C4 14 C3 68 30 80-40 00 E8 60 00 00 00 83
```

SRE EXAMPLE

```
.text:00401003                push    offset aEnterSerialNum ; "\nEnter Serial Number\n"
.text:00401008                call    sub_4010AF
.text:0040100D                lea     eax, [esp+18h+var_14]
.text:00401011                push    eax
.text:00401012                push    offset aS       ; "%s"
.text:00401017                call    sub_401098
.text:0040101C                push    8
.text:0040101E                lea     ecx, [esp+24h+var_14]
.text:00401022                push    offset aS123n456 ; "S123N456"
.text:00401027                push    ecx
.text:00401028                call    sub_401060
.text:0040102D                add     esp, 18h
.text:00401030                test    eax, eax
.text:00401032                jz      short loc_401045
.text:00401034                push    offset aErrorIncorrect ; "Error! Incorrect serial number.
.text:00401039                call    sub_4010AF
```

test eax,eax gives AND of eax with itself

- Result is 0 only if eax is 0
- If test returns 0, then jz is true

Trudy wants jz to always be true!

Can Trudy patch exe so that jz always true?

SRE EXAMPLE

Can you modify exe so that jz always true?

```
.text:00401003                 push    offset aEnterSerialNum ; "\nEnter Serial Number\n"
.text:00401008                 call    sub_4010AF
.text:0040100D                 lea     eax, [esp+18h+var_14]
.text:00401011                 push    eax
.text:00401012                 push    offset aS       ; "%s"
.text:00401017                 call    sub_401098
.text:0040101C                 push    8
.text:0040101E                 lea     ecx, [esp+24h+var_14]
.text:00401022                 push    offset aS123n456 ; "S123N456"
.text:00401027                 push    ecx
.text:00401028                 call    sub_401060
.text:0040102D                 add     esp, 18h
.text:00401030           xor   test    eax, eax
.text:00401032                 jz      short loc_401045
.text:00401034                 push    offset aErrorIncorrect ; "Error! Incorrect serial number.
.text:00401039                 call    sub_4010AF
```

SRE EXAMPLE

- Edit serial.exe with hex editor

serial.exe

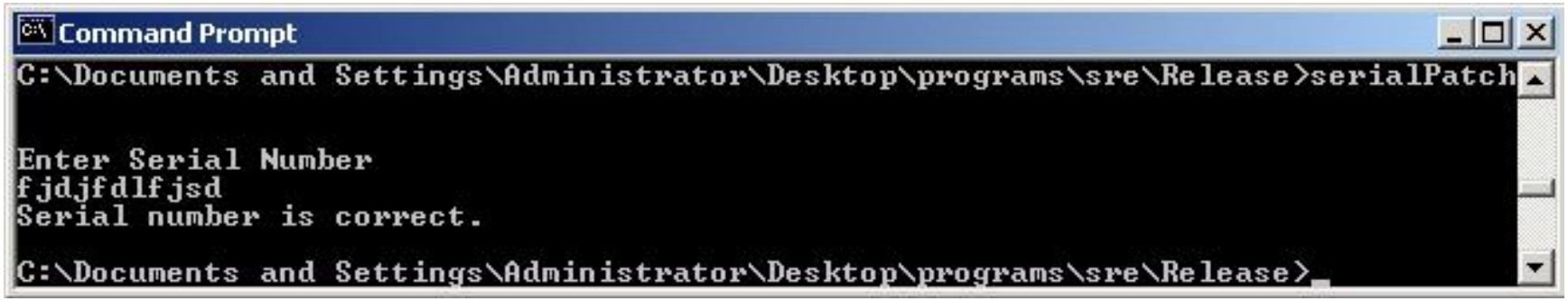
```
00001010h: 04 50 68 84 80 40 00 E8 7C 00 00 00 6A 08 8D 4C
00001020h: 24 10 68 78 80 40 00 51 E8 33 00 00 00 83 C4 18
00001030h: 85 C0 74 11 68 4C 80 40 00 E8 71 00 00 00 83 C4
00001040h: 04 83 C4 14 C3 68 30 80 40 00 E8 60 00 00 00 83
00001050h: C4 04 83 C4 14 C3 90 90 90 90 90 90 90 90 90 90
```

serialPatch.exe

```
00001010h: 04 50 68 84 80 40 00 E8 7C 00 00 00 6A 08 8D 4C
00001020h: 24 10 68 78 80 40 00 51 E8 33 00 00 00 83 C4 18
00001030h: 33 C0 74 11 68 4C 80 40 00 E8 71 00 00 00 83 C4
00001040h: 04 83 C4 14 C3 68 30 80 40 00 E8 60 00 00 00 83
00001050h: C4 04 83 C4 14 C3 90 90 90 90 90 90 90 90 90 90
```

Save as serialPatch.exe

SRE EXAMPLE


Command Prompt
C:\Documents and Settings\Administrator\Desktop\programs\sre\Release>serialPatch
Enter Serial Number
fjdjfdlfjsd
Serial number is correct.
C:\Documents and Settings\Administrator\Desktop\programs\sre\Release>

SRE EXAMPLE

serial.exe

```
.text:00401003    push    offset aEnterSerialNum ; "\nEnter Serial Number\n"
.text:00401008    call    sub_4010AF
.text:0040100D    lea     eax, [esp+18h+var_14]
.text:00401011    push    eax
.text:00401012    push    offset aS       ; "%s"
.text:00401017    call    sub_401098
.text:0040101C    push    8
.text:0040101E    lea     ecx, [esp+24h+var_14]
.text:00401022    push    offset aS123n456 ; "S123N456"
.text:00401027    push    ecx
.text:00401028    call    sub_401060
.text:0040102D    add     esp, 18h
.text:00401030    test    eax, eax
.text:00401032    jz      short loc_401045
.text:00401034    push    offset aErrorIncorrect ; "Error! Incorrect serial number.
.text:00401039    call    sub_4010AF
```

serialPatch.exe

```
.text:00401003    push    offset aEnterSerialNum ; "\nEnter Serial Number\n"
.text:00401008    call    sub_4010AF
.text:0040100D    lea     eax, [esp+18h+var_14]
.text:00401011    push    eax
.text:00401012    push    offset aS       ; "%s"
.text:00401017    call    sub_401098
.text:0040101C    push    8
.text:0040101E    lea     ecx, [esp+24h+var_14]
.text:00401022    push    offset aS123n456 ; "S123N456"
.text:00401027    push    ecx
.text:00401028    call    sub_401060
.text:0040102D    add     esp, 18h
.text:00401030    xor     eax, eax
.text:00401032    jz      short loc_401045
.text:00401034    push    offset aErrorIncorrect ; "Error! Incorrect serial number.
.text:00401039    call    sub_4010AF
```

SRE ATTACK MITIGATION

- Impossible to prevent SRE on open system
- But can make such attacks more difficult
- Anti-disassembly techniques
  - To confuse static view of code
- Anti-debugging techniques
  - To confuse dynamic view of code
- Tamper-resistance
  - Code checks itself to detect tampering
- Code obfuscation
  - Make code more difficult to understand