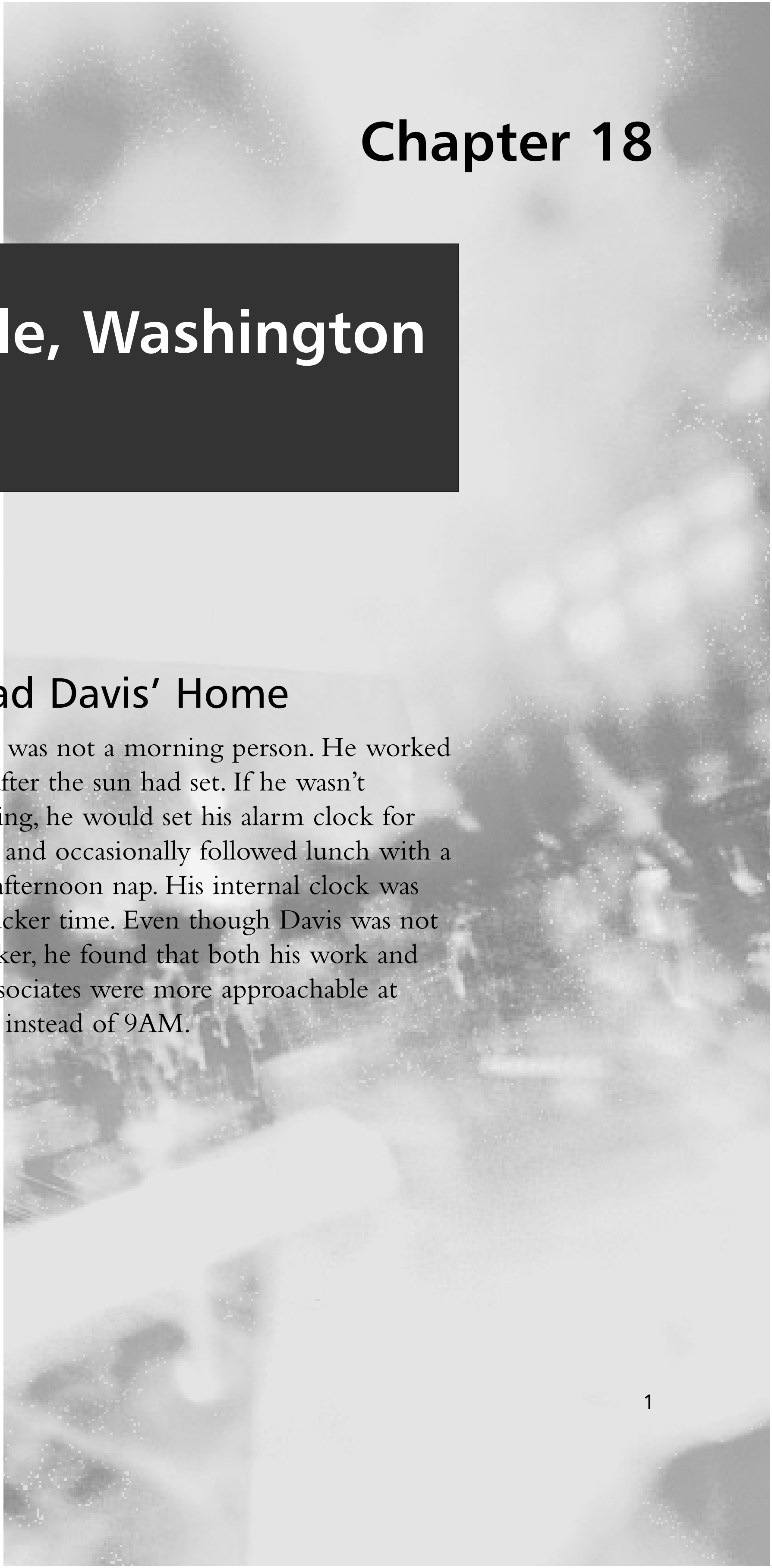


Chapter 18

Seattle, Washington

Chad Davis' Home

Chad was not a morning person. He worked best after the sun had set. If he wasn't teaching, he would set his alarm clock for noon and occasionally followed lunch with a mid-afternoon nap. His internal clock was on hacker time. Even though Davis was not a hacker, he found that both his work and his associates were more approachable at 2AM instead of 9AM.

Even though he had been on an airplane for half of the previous day, Davis could not go to sleep without tinkering with something. Usually it was some new debugger, plowing through e-mail or reviewing papers, but last night Chad Davis had more pressing concerns: what the hell did Baff have on that CD? It must have lingered in his sleep, because he was up before nine o'clock preparing a meal he was very unfamiliar with: breakfast.

As the eggs scrambled and bread toasted he powered-up his laptop ready to again attack the CD. Setting his plate down with eggs, toast, some microwaved bacon, and condiments; he remembered to call Hans Sheridan, one of his best friends and an FBI agent.

"Good *morning*," Davis proudly said as Hans picked up, making sure to point out his accomplishment.

"Chad? Are you sleepwalking or something? It's not April fools is it?" Hans replied with characteristic sarcasm.

"I know I know. Hey, there's a first time for everything. Haven't heard from you in a while. How are things going?"

"Pretty good. We've been busy this past month. I had a couple of trips outside of the field office these past few weeks and now I am back home. How about you? What do I owe this relatively early call to?"

"Well obviously I would not be calling you before noon on a Saturday if I didn't have a favor to ask."

Hans laughed, "As usual. What is it? A parking ticket? Indecent exposure? Hey you just came from Amsterdam right? I have some penicillin if you need it."

Chad hesitated for a minute. He quickly thought about what he was about to ask and where he was about to do it from.

"Funny. Hey Hans let me call you right back. I got breakfast on the stove."

"Wow, not only are you up in time for breakfast, you're actually cooking something! This must be serious. Ok, don't keep me waiting too long."

"Just give me a minute," replied Davis and hung up.

He walked over to his desk after quickly taking a small bite of his now luke-warm eggs and toast. Among the piles of papers he grabbed his cell phone and called Hans again.

"Sorry about that. My eggs were browning."

Hans smirked, realizing by his caller ID that Chad had switched from his land line to his cell phone,"No problem. I hope they still taste good."

"Yeah, as good as I'll ever make them. So, I have a question for you. I was at the airport in Amsterdam and got questioned by Interpol…"

Hans interrupted inquisitively,"Interpol? In Amsterdam? What were they doing there?"

"Yeah, well hindsight is always twenty/twenty. I guess your Bureau-trained paranoia hasn't rubbed off on me. So can you find out any info on the Agent that stopped me?"

"I can try.You got his name?" asked Hans.

"Sure, hold on a second."

Davis grabbed his carry-on bag and searched through his papers, pens, and accumulating garbage. He removed the card with his scribbled writing and reached for his cell phone,"You still there? Ok, it's Jonas Borgstand. Let me spell it."

"Got it. Give me an hour or so and I'll see what I can get. Maybe you should get some sleep."

"Thanks, I owe you one."

Ending the call, Davis' stomach growled at him for ignoring his now stale, cold, and probably tasteless eggs. He sat down and stared at them on his plate contemplating what he was going to eat besides them. *Cereal is always a good start to the day.*

After a couple of bowls he decided to plunge into that CD and not come out until he figured out what Baff wanted to show him.

Davis opened his laptop, ready to do battle. Some sleep was all he needed to get a fresh perspective on Baff's little brainteaser. Davis knew that he could potentially spend weeks trying to decipher Baff's cryptic text file. *Maybe it doesn't mean anything, knowing Baff he probably just needed to take a note or something and accidentally saved it to disk.*

Davis didn't believe that, but it was too early in the morning to admit he had intellectual limitations and just couldn't figure it out. It was partially an excuse to try some of his honed reverse engineering skills.

Reverse engineering software is the art and science of understanding and manipulating software after it has been compiled, and during the past three years Davis had become a master. When a person writes a computer program, they tell the computer's hardware what to do by giving it a series of instructions. At their lowest level, computer instructions are represented as bits – binary digits that have two states, on or off, one or zero. Most of the time, when one sees these instructions, they are represented in hexadecimal (base 16). Instructions are usually visible if one opens an executable file in a hexadecimal editor or hex editor. An executable file is just a collection of these instructions and some data that these instructions will operate with or on.

In the early days of computing, programmers would write complex programs using these instructions directly. Programmers who wrote endless strings of hexadecimal numbers would command absolute power over machines that occupied rooms the size of warehouses. Efforts were made to make the process of writing machine instruction easier by allowing programmers to write short, English-like codes to represent a series of numeric instructions. These mnemonics became known as assembly language. When a programmer was finished writing his or her instructions in assembly, a piece of software known as an assembler would convert these mnemonics into their machine-instruction equivalents. People soon realized that they were writing the same sets of instructions over and over again. A mechanism was needed to both encapsulate these instructions and to make the process of controlling a machine simpler. The result was the development of so-called high-level languages that allowed users to program with English-like constructs. These program files would then be converted into machine code using a compiler. Most modern applications are written by teams of programmers using various high-level languages like C, C++ and Java.

Davis realized that a huge misconception about compilers lingered in the minds of programmers. Most programmers believe that once an application was compiled and in machine-executable form that it was unalterable. Beyond that, many believed that any secrets hidden within the lines of source code like passwords were locked in an impenetrable vault by the compiler, a vault to which no one had the combination.

Reality, he knew, was quite different. People like Baff made their livings by changing the behavior of software. Most of the time, the behavior that they worked to change had to do with the software's restrictions on copying or distributing it. Many companies for example, choose to make users "activate" their products either through the Internet or by a key given over the phone. This activated software would then be fully functional on the machine it was originally installed on but useless on any other machine. Other software vendors had begun to raise the ante by distributing hardware "keys" that needed to be inserted into the machine to run their application. All of these methods were created in an effort to stop software pirates from copying and distributing software without paying for it; over the years all had been broken.

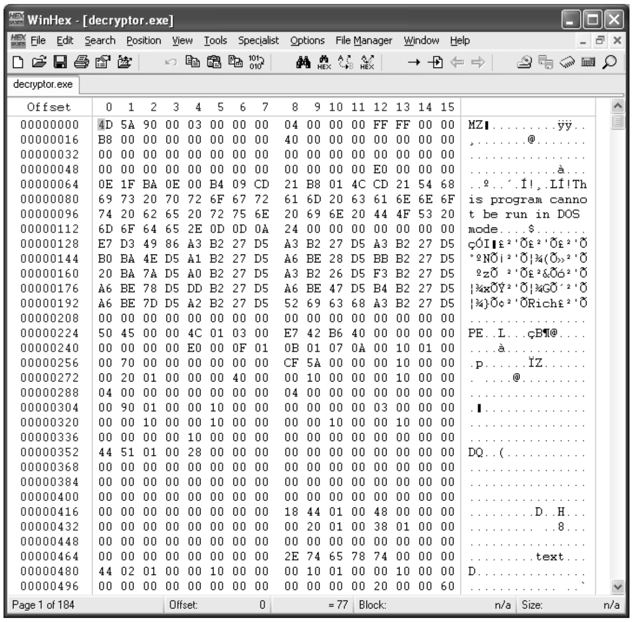
Davis's interest today was not in removing copy protection; it was getting that damn decryptor to work. His first step was to use a hex editor to examine the decryption program.

Abstractly, there are two ways to manipulate and inspect software: statically or dynamically. Dynamic analysis is done while the application is running, usually by watching the application execute instruction by instruction usually using a debugger. Baff had obviously thought hard about protecting against this. On the plane Davis hit a silicone wall. He threw several commercial debuggers at the application, even an advanced one that Davis himself had written, all failed. Baff was good.

It was now time to do some static analysis; dissecting the binary file itself using some inspection tools. Davis' first step was always a hex editor.

To the casual user, the output of a hex editor is a sea of garbage; meaningless characters that somehow must miraculously come together to make a program do what it does when they execute it.

Output of the Hex Editor


WinHex - [decryptor.exe]
File Edit Search Position View Tools Specialist Options File Manager Window Help
HEX
decryptor.exe

```
 Offset     0  1  2  3  4  5  6  7   8  9 10 11 12 13 14 15
00000000   4D 5A 90 00 03 00 00 00  04 00 00 00 FF FF 00 00   MZ▮.........ÿÿ..
00000016   B8 00 00 00 00 00 00 00  40 00 00 00 00 00 00 00   ¸.......@.......
00000032   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
00000048   00 00 00 00 00 00 00 00  00 00 00 00 E0 00 00 00   ............à...
00000064   0E 1F BA 0E 00 B4 09 CD  21 B8 01 4C CD 21 54 68   ..º..´.Í!¸.LÍ!Th
00000080   69 73 20 70 72 6F 67 72  61 6D 20 63 61 6E 6E 6F   is program canno
00000096   74 20 62 65 20 72 75 6E  20 69 6E 20 44 4F 53 20   t be run in DOS 
00000112   6D 6F 64 65 2E 0D 0D 0A  24 00 00 00 00 00 00 00   mode....$.......
00000128   E7 D3 49 86 A3 B2 27 D5  A3 B2 27 D5 A3 B2 27 D5   çÓI▮£²'Õ£²'Õ£²'Õ
00000144   B0 BA 4E D5 A1 B2 27 D5  A6 BE 28 D5 BB B2 27 D5   °ºNÕ¡²'Õ¦¾(Õ»²'Õ
00000160   20 BA 7A D5 A0 B2 27 D5  A3 B2 26 D5 F3 B2 27 D5    ºzÕ ²'Õ£²&Õó²'Õ
00000176   A6 BE 78 D5 DD B2 27 D5  A6 BE 47 D5 B4 B2 27 D5   ¦¾xÕÝ²'Õ¦¾GÕ´²'Õ
00000192   A6 BE 7D D5 A2 B2 27 D5  52 69 63 68 A3 B2 27 D5   ¦¾}Õ¢²'ÕRich£²'Õ
00000208   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
00000224   50 45 00 00 4C 01 03 00  E7 42 B6 40 00 00 00 00   PE..L...çB¶@....
00000240   00 00 00 00 E0 00 0F 01  0B 01 07 0A 00 10 01 00   ....à...........
00000256   00 70 00 00 00 00 00 00  CF 5A 00 00 00 10 00 00   .p......ÏZ......
00000272   00 20 01 00 00 00 40 00  00 10 00 00 00 10 00 00   . ....@.........
00000288   04 00 00 00 00 00 00 00  04 00 00 00 00 00 00 00   ................
00000304   00 90 01 00 00 10 00 00  00 00 00 00 03 00 00 00   .▮..............
00000320   00 00 10 00 00 10 00 00  00 00 10 00 00 10 00 00   ................
00000336   00 00 00 00 10 00 00 00  00 00 00 00 00 00 00 00   ................
00000352   44 51 01 00 28 00 00 00  00 00 00 00 00 00 00 00   DQ..(...........
00000368   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
00000384   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
00000400   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
00000416   00 00 00 00 00 00 00 00  18 44 01 00 48 00 00 00   .........D..H...
00000432   00 00 00 00 00 00 00 00  00 20 01 00 38 01 00 00   ......... ..8...
00000448   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
00000464   00 00 00 00 00 00 00 00  2E 74 65 78 74 00 00 00   .........text...
00000480   44 02 01 00 00 10 00 00  00 10 01 00 00 10 00 00   D...............
00000496   00 00 00 00 00 00 00 00  00 00 00 00 20 00 00 60   ............ ..`
```

Page 1 of 184 | Offset: 0 | = 77 | Block: n/a | Size: n/a

Davis looked at the output and saw much more. He saw an application, baring its secrets, its purpose. He had learned to do some amazing things by editing a program directly in a hex editor over the last few years. He could change how the application behaved, how it responded to input and how it looked. He could also add features and change flawed ones at the lowest possible level.

This skill had made Chad Davis a lot of money in 1999, when many companies were throwing money at anyone who could soothe their Y2K computer fears. Most companies were still running ancient software that used two digits to represent which year a transaction or event had or was taking place. When the original programmers had developed these applications no one thought that they would still be in use a decade or sometimes two decades later. The fear was that when that year rolled around from 99 to 00 many applications would fail either by instantly archiving transactions that took place in 2000 as 100 years old, automatically voiding transactions, dividing by the year 00 or other unimaginable horrors. It was during this period that Davis mastered the art of bending software to his will. He would have to modify old applications for which the source code was either lost or unavailable and make the work with the new date format. If anyone could make this decryptor give up its secrets, it was Chad Davis.

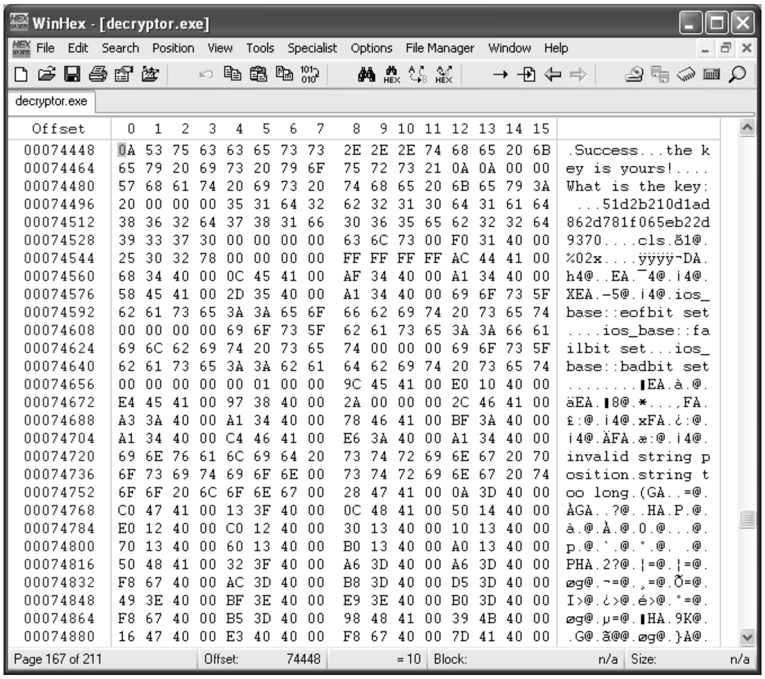
Davis skimmed the output from the hex editor. Nothing immediately obvious. There were some strings that looked like ASCII art. A few interesting phrases:

```
"Success…the key is yours!"
```

followed by a peculiar 32 character long number. By its length, and its placement within the binary Davis assumed it could be only on thing: a password hash!

```
51d2b210d1ad862d781f065eb22d9370
```

Interesting Phrases and Numbers


WinHex - [decryptor.exe]
File Edit Search Position View Tools Specialist Options File Manager Window Help
decryptor.exe

```
  Offset      0  1  2  3  4  5  6  7   8  9 10 11 12 13 14 15
 00074448    0A 53 75 63 63 65 73 73  2E 2E 2E 74 68 65 20 6B   .Success...the k
 00074464    65 79 20 69 73 20 79 6F  75 72 73 21 0A 0A 00 00   ey is yours!....
 00074480    57 68 61 74 20 69 73 20  74 68 65 20 6B 65 79 3A   What is the key:
 00074496    20 00 00 00 35 31 64 32  62 32 31 30 64 31 61 64    ...51d2b210d1ad
 00074512    38 36 32 64 37 38 31 66  30 36 35 65 62 32 32 64   862d781f065eb22d
 00074528    39 33 37 30 00 00 00 00  63 6C 73 00 F0 31 40 00   9370....cls.ð1@.
 00074544    25 30 32 78 00 00 00 00  FF FF FF FF AC 44 41 00   %02x....ÿÿÿÿ¬DA.
 00074560    68 34 40 00 0C 45 41 00  AF 34 40 00 A1 34 40 00   h4@..EA.¯4@.¡4@.
 00074576    58 45 41 00 2D 35 40 00  A1 34 40 00 69 6F 73 5F   XEA.-5@.¡4@.ios_
 00074592    62 61 73 65 3A 3A 65 6F  66 62 69 74 20 73 65 74   base::eofbit set
 00074608    00 00 00 00 69 6F 73 5F  62 61 73 65 3A 3A 66 61   ....ios_base::fa
 00074624    69 6C 62 69 74 20 73 65  74 00 00 00 69 6F 73 5F   ilbit set...ios_
 00074640    62 61 73 65 3A 3A 62 61  64 62 69 74 20 73 65 74   base::badbit set
 00074656    00 00 00 00 00 01 00 00  9C 45 41 00 E0 10 40 00   ........▮EA.à.@.
 00074672    E4 45 41 00 97 38 40 00  2A 00 00 00 2C 46 41 00   äEA.▮8@.*...,FA.
 00074688    A3 3A 40 00 A1 34 40 00  78 46 41 00 BF 3A 40 00   £:@.¡4@.xFA.¿:@.
 00074704    A1 34 40 00 C4 46 41 00  E6 3A 40 00 A1 34 40 00   ¡4@.ÄFA.æ:@.¡4@.
 00074720    69 6E 76 61 6C 69 64 20  73 74 72 69 6E 67 20 70   invalid string p
 00074736    6F 73 69 74 69 6F 6E 00  73 74 72 69 6E 67 20 74   osition.string t
 00074752    6F 6F 20 6C 6F 6E 67 00  28 47 41 00 0A 3D 40 00   oo long.(GA..=@.
 00074768    C0 47 41 00 13 3F 40 00  0C 48 41 00 50 14 40 00   ÀGA..?@..HA.P.@.
 00074784    E0 12 40 00 C0 12 40 00  30 13 40 00 10 13 40 00   à.@.À.@.0.@...@.
 00074800    70 13 40 00 60 13 40 00  B0 13 40 00 A0 13 40 00   p.@.`.@.°.@. .@.
 00074816    50 48 41 00 32 3F 40 00  A6 3D 40 00 A6 3D 40 00   PHA.2?@.¦=@.¦=@.
 00074832    F8 67 40 00 AC 3D 40 00  B8 3D 40 00 D5 3D 40 00   øg@.¬=@.¸=@.Õ=@.
 00074848    49 3E 40 00 BF 3E 40 00  E9 3E 40 00 B0 3D 40 00   I>@.¿>@.é>@.°=@.
 00074864    F8 67 40 00 B5 3D 40 00  98 48 41 00 39 4B 40 00   øg@.µ=@.▮HA.9K@.
 00074880    16 47 40 00 E3 40 40 00  F8 67 40 00 7D 41 40 00   .G@.ã@@.øg@.}A@.
```

Page 167 of 211 | Offset: 74448 | = 10 | Block: n/a | Size: n/a

Hashes were a testimony to modern cryptography. Davis had used their power several times in his programming days as a graduate student. A hash function reads a long string or file as input and produces a "digest" of that data. Ideally, the security properties of these functions ensure that the digest looks "random" and does not leak any information about the data itself, and that other messages can not be found that produce the same digest. Specifically, what makes these numbers interesting is that they have a few very desirable properties.

First, finding an input that produces a given hash is (hopefully) extremely hard. Second, finding two inputs that hash to the same result is difficult (if not impossible). Third, knowing the hash, you cannot re-compute the original data; thus, hash functions are also known as one-way functions. Finally, small changes in the data can cause drastic changes in the value of the computed hash.

One application of hashes is to ensure that files are not tampered with. One can compute the value of a file when it is in a known, "good" state and save that hash value off in a safe place. Later, one could compute the hash of that file again and compare the old value with the new: if the two match, the file has not been tampered with. It was doubtful that this was the way Baff was using it. For one, it was stored in the file itself. That means if the user changed the file, or a part of the file, they could also re-compute and change the stored hash value. Baff was too clever for that. Another popular use of hashes was to store passwords. Davis figured that this is exactly what Baff was doing.

Baff, you bastard!

The general problem with storing passwords in a program is that an attacker with a hex editor might be able to see that password stored in binary and then use it. Using hashes was a good alternative. Davis knew that this is how most of the widely-used operating systems like most flavors of Linux, UNIX and Windows managed passwords. In most versions of Windows, for instance, when a user logs in, a hash of the password is calculated and then compared with a hash of the original password stored when the password was originally set. The result is nobody's password is actually stored on the machine, only the hashes. This is the reason that a system administrator is often unable to tell you your forgotten password but they are able to set a new one. Apparently Baff had taken the same approach with his decryptor.

Like any cryptography though, this could be broken. The only question was how long would it take. Davis had used some of the dubbed "password recovery" tools – which were usually used as "password theft" tools – like L0pht Crack for Windows passwords and John the Ripper for UNIX/Linux. For a funded project through the U.S. Navy, Davis had also written several of his own tools. Most of these tools worked by "brute-forcing" passwords – trying various combinations of letters, numbers and special characters, computing their hashes, and then comparing these computed hashes with the one stored. For operating system passwords, many tools can recover a reasonably complex password from a hash in a few hours – likely trying several million combinations in the process. Davis knew that his task was harder. For operating system passwords, there are a few things that make the process easier. For one, usually there is a known maximum length like 8 or 16 characters. Davis had no idea what kind of password Baff was expecting. One character, ten, a hundred; all possibilities. Davis did not have that luxury. His testimony was a couple of days away, and he had to know what Baff had found.

When Davis studied cryptography as a graduate student at Carnegie Mellon he was amazed at how widely these techniques had been used during the two World Wars. Many battles had been won or lost based on how skilled each side was at breaking encoded messages. What amazed Davis at the time was how breakable many of the systems were. The important thing was how long it would take to break it.

Ok Baff, let's do this…

Davis knew that the sledge hammer approach would not work in time. There had to be another way. Davis knew that there were two widely used families hashing algorithms: the Secure Hash Algorithms (SHA) and the Message Digest (MD). Baff's hash had 32 hexadecimal characters which meant it was probably either MD4 or MD5, both of which had a 128bit = 32 hex character hash value. Most of the world had moved from MD4 to MD5 which was more difficult to crack. From what he had seen so far, Davis was pretty sure that Baff would pick the harder one.

MD5 it is.

Again, trying to attack the cryptography directly was not an option. Davis recalled the first try-and-buy-software that he cracked. He changed the hard-coded date that helped the software compute its expiry time. In the early days some software developers started to use this method to get around the setting the system clock back trick. Looking back, Davis recalled what a horrible scheme that was. He changed the stored date from 1993 to 2013 and the application worked like a charm. *Fifteen bucks saved!* He was about to apply the same principal here.

If I can calculate the hash to a password that I do know, maybe I can replace the stored key with the fake key. Then I enter the password that corresponds to that key! Damn I'm good!

He was good, but so was Baff. Obviously Baff wanted him to crack this thing if anything happened but why did he have to make it so goddamned difficult. Davis opened up a web browser and found a free MD5 hash calculator.

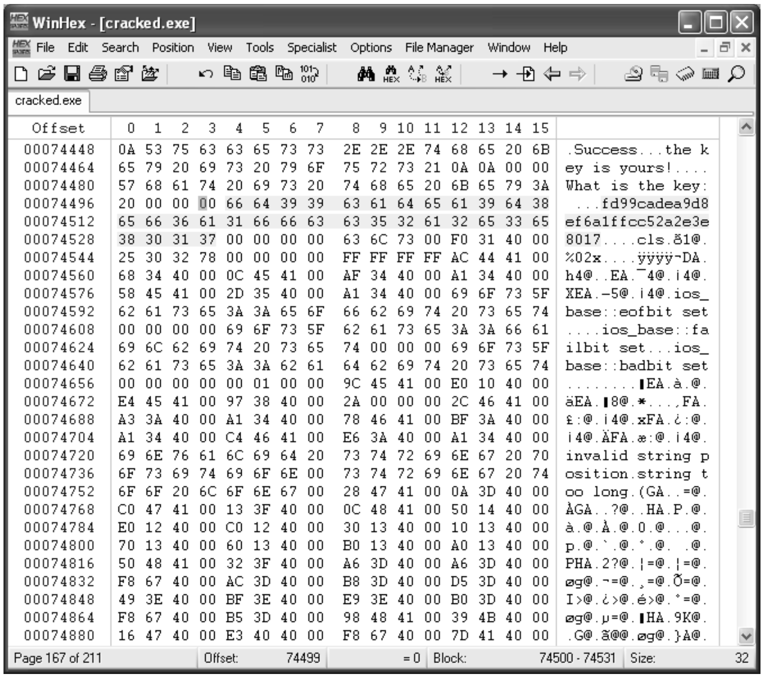
Hmmm…now for a password…ah, why not…

Davis entered the string "advice" and the resulting hash was:

```
fd99cadea9d8ef6a1ffcc52a2e3e8017
```

Davis had a plan. He had his string. He had its hash. It was time for this application to suffer. Davis again opened up his hex editor and faithfully replaced the original hash with the new value he computed and saved the modified file as c:\cracked.exe.

Hex Editor with Replaced Hash


WinHex - [cracked.exe]
File Edit Search Position View Tools Specialist Options File Manager Window Help
cracked.exe

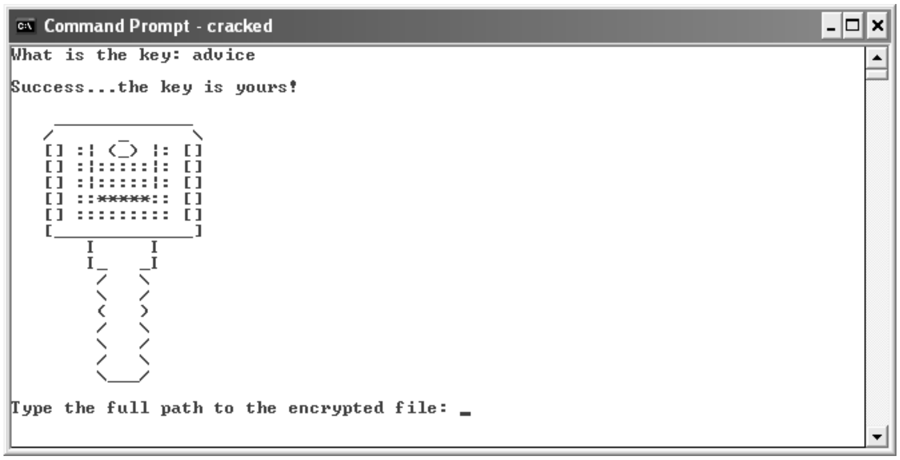
```
  Offset     0  1  2  3  4  5  6  7   8  9 10 11 12 13 14 15
 00074448   0A 53 75 63 63 65 73 73  2E 2E 2E 74 68 65 20 6B   .Success...the k
 00074464   65 79 20 69 73 20 79 6F  75 72 73 21 0A 0A 00 00   ey is yours!....
 00074480   57 68 61 74 20 69 73 20  74 68 65 20 6B 65 79 3A   What is the key:
 00074496   20 00 00 00 66 64 39 39  63 61 64 65 61 39 64 38    ...fd99cadea9d8
 00074512   65 66 36 61 31 66 66 63  63 35 32 61 32 65 33 65   ef6a1ffcc52a2e3e
 00074528   38 30 31 37 00 00 00 00  63 6C 73 00 F0 31 40 00   8017....cls.ð1@.
 00074544   25 30 32 78 00 00 00 00  FF FF FF FF AC 44 41 00   %02x....ÿÿÿÿ¬DA.
 00074560   68 34 40 00 0C 45 41 00  AF 34 40 00 A1 34 40 00   h4@..EA.¯4@.¡4@.
 00074576   58 45 41 00 2D 35 40 00  A1 34 40 00 69 6F 73 5F   XEA.-5@.¡4@.ios_
 00074592   62 61 73 65 3A 3A 65 6F  66 62 69 74 20 73 65 74   base::eofbit set
 00074608   00 00 00 00 69 6F 73 5F  62 61 73 65 3A 3A 66 61   ....ios_base::fa
 00074624   69 6C 62 69 74 20 73 65  74 00 00 00 69 6F 73 5F   ilbit set...ios_
 00074640   62 61 73 65 3A 3A 62 61  64 62 69 74 20 73 65 74   base::badbit set
 00074656   00 00 00 00 00 01 00 00  9C 45 41 00 E0 10 40 00   ........▮EA.à.@.
 00074672   E4 45 41 00 97 38 40 00  2A 00 00 00 2C 46 41 00   äEA.▮8@.*...,FA.
 00074688   A3 3A 40 00 A1 34 40 00  78 46 41 00 BF 3A 40 00   £:@.¡4@.xFA.¿:@.
 00074704   A1 34 40 00 C4 46 41 00  E6 3A 40 00 A1 34 40 00   ¡4@.ÄFA.æ:@.¡4@.
 00074720   69 6E 76 61 6C 69 64 20  73 74 72 69 6E 67 20 70   invalid string p
 00074736   6F 73 69 74 69 6F 6E 00  73 74 72 69 6E 67 20 74   osition.string t
 00074752   6F 6F 20 6C 6F 6E 67 00  28 47 41 00 0A 3D 40 00   oo long.(GA..=@.
 00074768   C0 47 41 00 13 3F 40 00  0C 48 41 00 50 14 40 00   ÀGA..?@..HA.P.@.
 00074784   E0 12 40 00 C0 12 40 00  30 13 40 00 10 13 40 00   à.@.À.@.0.@...@.
 00074800   70 13 40 00 60 13 40 00  B0 13 40 00 A0 13 40 00   p.@.`.@.°.@. .@.
 00074816   50 48 41 00 32 3F 40 00  A6 3D 40 00 A6 3D 40 00   PHA.2?@.¦=@.¦=@.
 00074832   F8 67 40 00 AC 3D 40 00  B8 3D 40 00 D5 3D 40 00   øg@.¬=@.¸=@.Õ=@.
 00074848   49 3E 40 00 BF 3E 40 00  E9 3E 40 00 B0 3D 40 00   I>@.¿>@.é>@.°=@.
 00074864   F8 67 40 00 B5 3D 40 00  98 48 41 00 39 4B 40 00   øg@.µ=@.▮HA.9K@.
 00074880   16 47 40 00 E3 40 40 00  F8 67 40 00 7D 41 40 00   .G@.ã@@.øg@.}A@.
```

Page 167 of 211 | Offset: 74499 | = 0 | Block: 74500 - 74531 | Size: 32

Now, the moment of truth…

Davis ran the modified file and once again was asked for the key. This time things were different, this time he had made his own key. Davis typed in "advice", his newly contrived password. With a quick press of the Enter key; success!

Success!



```
What is the key: advice

Success...the key is yours!


    _____________
   /      _      \
   [] :| (_) |: []
   [] :|:::::|: []
   [] :|:::::|: []
   [] ::*****:: []
   [] ::::::::: []
   [_____________]
       I     I
       I_   _I
        /   \
        \   /
        <   >
        /   \
        \   /
        /   \
        \___/

Type the full path to the encrypted file: _
```

Davis looked with amazement at the screen in front of him; he had done it. He gave the application the location for Baff's mysterious encrypted file and gave it the location for the decrypted file. Within seconds it had produced its result. Davis quickly opened the decrypted file in his hex editors. Symbols, characters, patterns he didn't recognize. He spent the next several minutes scrolling through it. It wasn't an executable, it did not have the right headers. It was not a document file, at least it was not in any format that he had ever seen before. He slammed his hands down on the desk.

This is complete garbage. Son of a bitch! I don't have time for this shit!

A ringing phone interrupted the audible string of profanities now freely flowing from Chad Davis.

"Hello!"

"Hey; easy. What the hell is the matter with you?"

"Sorry Hans. I am about to take an axe to this CD I'm working on cracking."

"CD? What are you joining the Spice Boys or something? You may not wanna' do that just yet. On a more pressing matter that boy of yours, Jonas whatever-the-fuck-his-name-was, is a ghost; Interpol never heard of him."

A cold shiver ran down both of Davis's arms. He was afraid of this, but what did it mean?

"Chad, you still there?"

"Yes, I'm here. Can we meet somewhere? How about Redmond Town Center, Thai restaurant in twenty?"

Davis' voice was overtly shaky. He had dealt with criminal elements before but they were hackers, guys who harmed bits, not people.

Had Jonas killed Baff? Is he trying to kill me?

The thought was too much for him to bear.

"I've got a better idea." Hans said in a decidedly different tone. "Remember that place where we met up about a month ago, I'll meet you there in an hour. Ok?"

"Ok. One hour."

Davis hung up the phone. His left hand trembled slightly as it let go of the receiver. Hans's last words had really shaken him:

The place we met last month? Why didn't he just say Starbucks on 45th? Is my phone being tapped? Does Hans know something he's not telling me?

The only explanation for Hans' vagueness that Davis could imagine was that he suspected a wire tap. It was now more important than ever to find out what Baff was trying to tell him.

Davis turned his attention back to the CD and tried to put the failure of the last two hours efforts behind him. His next step was to use a disassembler to try and find out why he had failed and how he could unlock what Baff had spent so much effort to keep hidden. A disassembler was the opposite of an assembler. While an assembler converts assembly commands into machine instructions, a disassembler attempts to convert machine instructions into assembly instructions which are easier read by humans rather than machines. Almost every operating system ships with an assembler and a disassembler that are installed by default. As Davis found out early in his professional career though, understanding how a binary works was an art, one that could not be fully captured in a rudimentary disassembly tool. Sometimes the process would take days of staring at complex control flow graphs and looking at hundreds of pages of assembly code. To be successful one had to become a detective, following digital clues and making leaps of deductive reasoning.

The right tools were essential. Davis opened the decryption program in Datarescue's Interactive Diasassembler (IDA Pro). IDA was not a tool for the casual computer user; it was a craftsman's tool, a tool meant to be wielded by software assassins.

Within 25 minutes of staring at IDA Pro Davis realized why his approach was doomed to fail. It appeared as if Baff actually used the characters in the unknown password itself to encrypt the file. The original password was needed if he was to make any sense of the encrypted file in time.

Davis looked down at the clock in the bottom right hand corner of his computer screen. And began to shut down his laptop and place it in a small carrying case.

I hope Hans has some answers!

A few dozen feet away in a white van, two men stared intently at the black and white video feed from Davis' home. Since listening in on the conversation between Davis and Hans minutes before, they knew one of them had to call Danko. People who knew Danko's identity tended not to live very long; he made sure of it.

"So are you gonna' call him?"

"I wouldn't call that man if his sister was the last woman in the world!" replied the man.

Even with rap sheets neither man wanted to call Danko with the news that Davis and Hans were on to him. After a minute one finally caved in.

"All right, give me the phone. Someone's in a shit-load of trouble."