CS 370, Assignment 2 Report

Cody Malick
malickc@oregonstate.edu

November 21, 2016

Part 1

2

First Hash:
SHA1(cow)= 3fb6542ba0cc9b35cf14bd8db9d33ac9669a898f
SHA256(cow)= 15fda678dfcc49b7c6e7e77fad66ffd5a5d1fa755df0363d04ce908942896b23

4

After bit flipped:
SHA1(cow)= ea69777a5effef525b4ef54bf5ee46900f15a6fa
SHA256(cow)= bf659b85ac3106f0b4672dd4b9eab8c4546bc49d1d28ac2c2b162a7d03ebf5c9

5

The bits between the keys are not similar. They are actually quite different. I believe this is caused by the avalanche effect, which is in effect in the SHA1 and SHA256 standard

6

bit position	1	49	73	113
sha1	40	40	40	40
sha256	60	60	60	60

The two hashes are very different between each hash, and their original unflipped form. Due to the avalanche, these bit flips will completely change the resulting hash in each case.

Part 2

128 character key
HMAC-SHA256(cow)= 63fd1176c5e507c90278349868916b8ed99a1ac71038e1af14804d65cf9473e1
HMAC-SHA1(cow)= 6957b44a3eae1693dade1bf969e66e1b65225fa5

160 character key
HMAC-SHA256(cow)= 4c8d099c09091f04f24649530bf1c6a6493c2c17ec99ebfd4e49b8370a70add8
HMAC-SHA1(cow)= a50ce33015af385ea52f943cdfe3ae0ec87635bd

256 character key
HMAC-SHA256(cow)= 1091ac33a2d021ccb2a24ebf498f60fa28c433dcdf43bd02ffbb122880809132
HMAC-SHA1(cow)= bc7323e59424db54eced37dce543cd194eb76a5f

Do we have to use a key with a fixed size in HMAC?

No, but a shorter key lowers the strength of the algorithm to the length of the key, and a longer key does not add extra strength to the hash.

If so, what is the key size? If not, why?

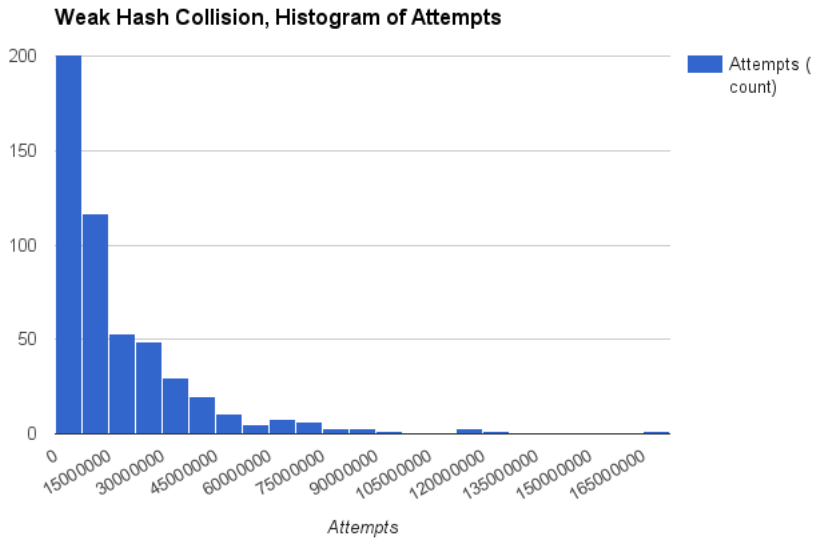
We don't have to use the hash size the algorithm calls for, but it would lower the strength of the hash to the size of the key provided. For example, a 128 bit key provided to SHA256 would lower the strength to 128 bit instead of the designated 256 bit value. The primary reason for the drop in strength is that the algorithm would have to loop back over the same key to xor the value we wish to hash using hmac.

If we used the correct size of the key or larger, we would be ensure the full strength of the key is utilized.

Part 3

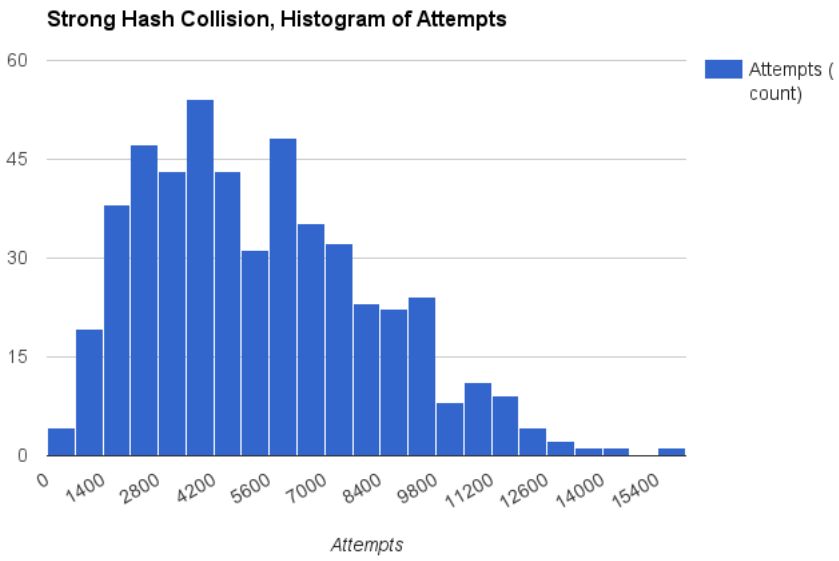
1

Weak Hash Collision:
500 Trials
Average Attempts: 16,811,276.65
Median Attempts: 10,439,032.5



2

Strong Hash Collision:
500 Trials
Average Attempts: 5,370.812
Median Attempts: 4,911.5



3

Trial description: Each trial used a randomized string (strong) or a randomized start hash (weak).

Overall, strong hash collision was much easier to break. Weak hash collision on a three byte has took several million trials on average, while a 3 byte hash took only about five thousand on average using strong hash collision.

Mathematical description
Weak collision:
The probability of guessing a certain hash out of a 24 bit hash is the very simple:

$$Prob = 1/(2^{24}) = 1/16777216 = 5.9604 * 10^{-8}$$

Strong collision:
For this equation, I'm plugging in the average number of attempts for n to give a reasonable estimate of the probability:

$$P(5370) = 1 - ((2^{24})!/((2^{24})^{(}5370) * (2^{24} - 5370)!))$$

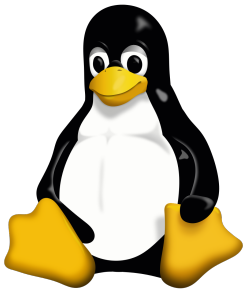
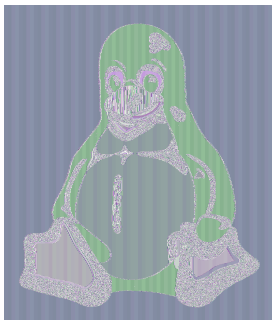
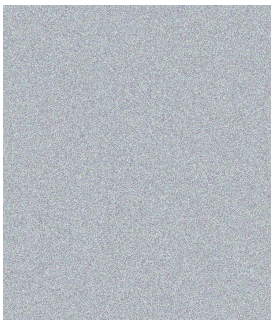
$= .5765$

An incredibly large guessing chance for such a small number of attempts.

Part 4

From the CBC mode encryption, it's just noise. But from ECB, I can clearly see the outline of Tux. While the colors are different, they are consistently different, allowing me to make out the original picture with some alterations.

Here are some small versions of the pictures, but you can find the originals in the appropriate folder (part 4).

Part 5

My answer for the correct key is the word 'median'. I had some trouble on this part of the assignment. Specifically, the hexadecimal conversion back and forth between strings. The other issue I ran into was my encryption function would only output the first half of the ciphertext correctly. I piped the output of my program into a file, and grepped for the key we were provided.