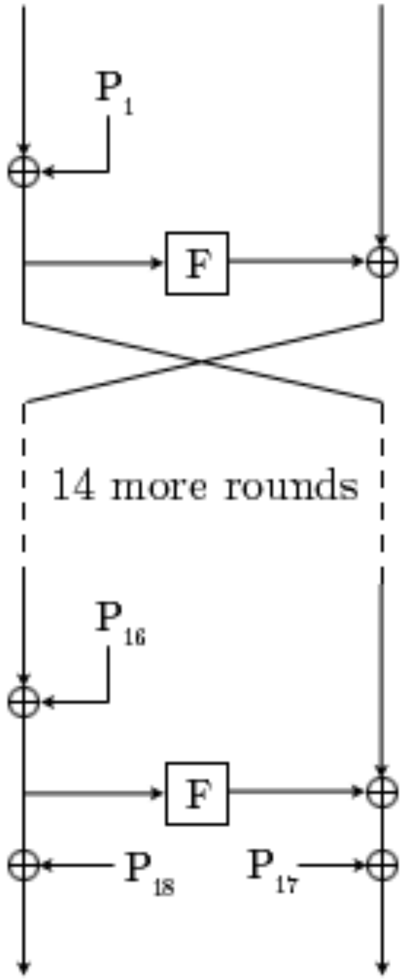
Blowfish

Wesley Wigham, Stephen Yingling, Chad Zawistowski

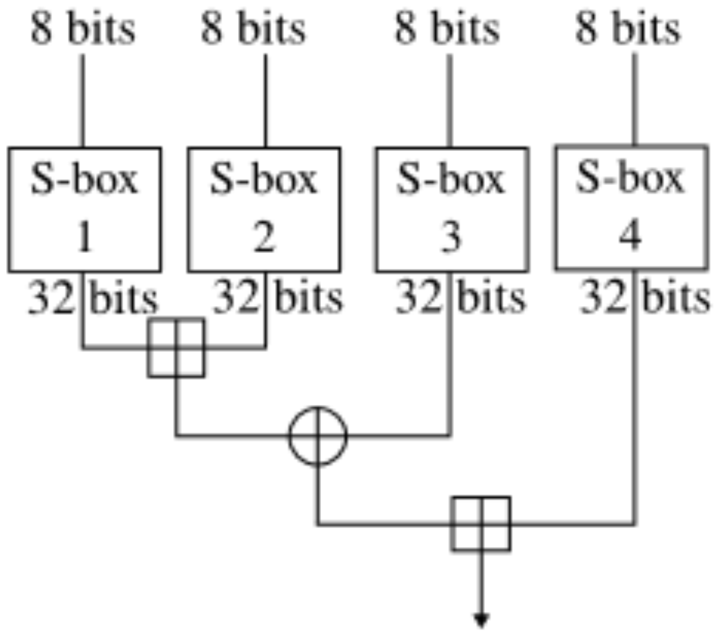
Blowfish

- Block size of 64 bits
- Key size of 64 bits
- Feistel Network
- Complex P-array and S-box initialization
    - Encrypts two entries to replace the next two
- 16 rounds



Blowfish (cont.)

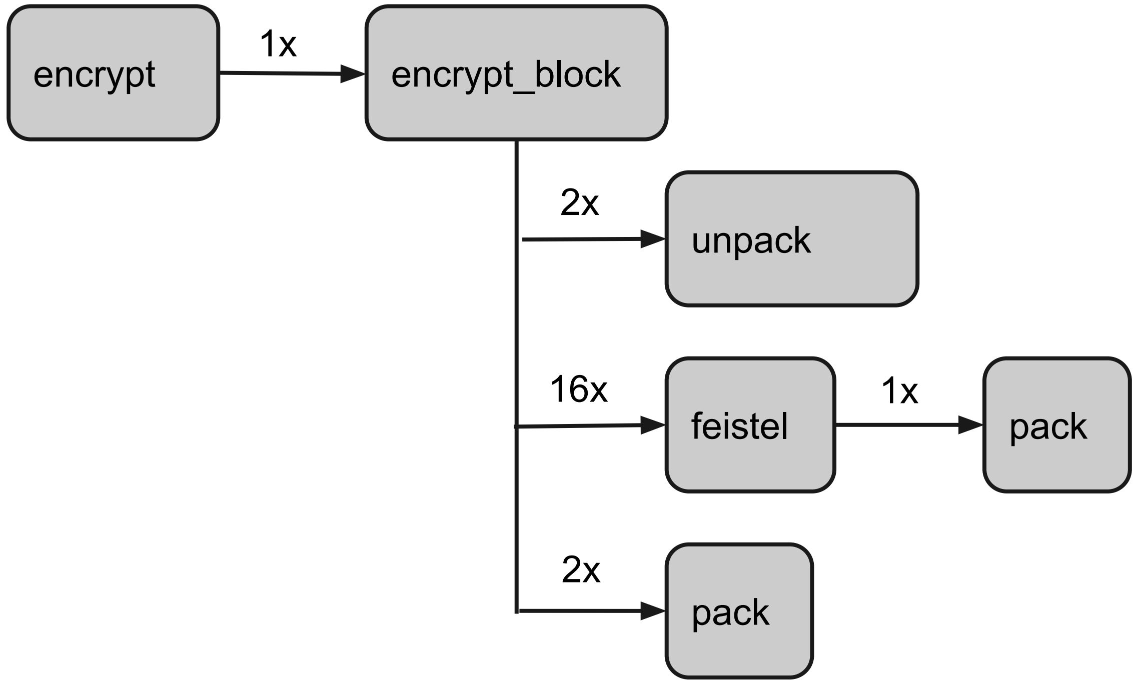
- The function f splits one of the 32-bit halves into 4 bytes
- Each byte is run through an S-box and then combined through addition/XOR



Original Implementation

- Used a for-loop to iterate through the rounds
- The feistel function was not inlined, and was called extremely often
- Generating S-boxes was slow, but was only performed once
- Python’s pack and unpack methods were used for converting between integers and byte arrays

Original Call Stack



Timetrial: Original

Encrypting the all-0 bytestring 2.5 million times (3 trials)

- Average Running Time: 197.279 seconds
- Total times spent in a selection of functions:
  - feistel = 82.666 secs
  - encrypt_block = 58.479 secs
  - pack = 31.230 secs
  - encrypt = 6.572 secs
  - unpack = 3.892 secs
  - generate S box = 0.002 secs

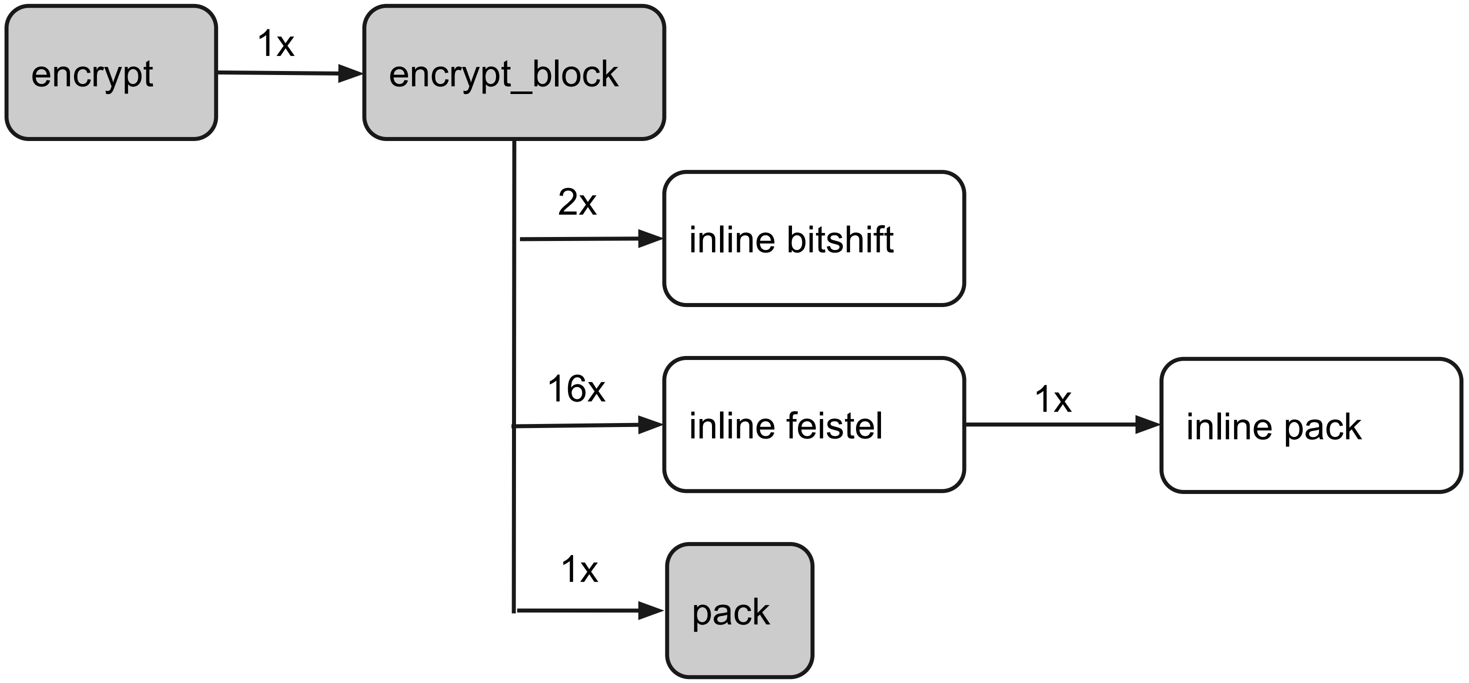
Analysis

- Spends a long time in encrypt_block
    - Mostly in ‘feistel’
        - The ‘feistel’ function incurs quite a bit of overhead, but is where most processing takes place
    - Secondarily in ‘pack’
        - python library call, converts bytearray to integer
        - ‘feistel’ also calls ‘pack’

Optimized Implementation

- Did in-place calculations of 2 rounds at once to avoid left-right swapping overhead
- Unrolled the rounds’ for-loop
- Inlined the feistel function to remove calling overhead
- Within ‘encrypt_block’, replaced calls to ‘pack’ with inline bit operations

Optimized Call Stack



Timetrial: Optimized

Encrypting the all-0 bytestring 2.5 million times (3 trials)

- Average Running Time: 68.125 seconds
- Total times spent in a selection of functions:
    - encrypt_block = 46.119 secs
    - encrypt = 6.561 secs
    - pack = 2.249 secs
    - generate S box = 0.012 secs
    - unpack = 0.001 secs

Results of Changes

- 2.94x faster overall
    - Switching to manual bitshift operations reduced time in pack by 29 seconds and in unpack by 3 seconds
    - Eliminated significant calling overhead by inlining the feistel function
    - Unrolled the for loop in encrypt_block and saved approximately 12 seconds

Optimization Lessons

- Python’s overhead for function calls becomes significant over billions of calls
- Python’s struct library is fairly inefficient for combining bytearrays of known size into integers

Future Work

- Replace the remaining pack and unpack functions with our own conversions
- Unroll loops within the S box generation function

Questions?

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