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CounterSEVeillance

Performance-Counter Attacks on AMD SEV-SNP

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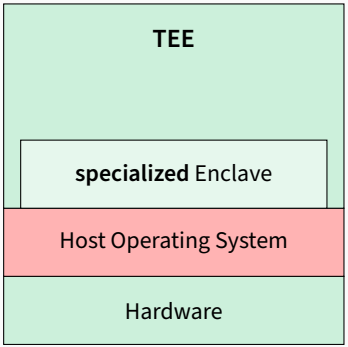
"Classical" TEEs vs. Confidential VMs



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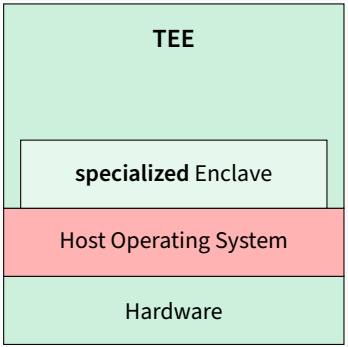

Constant-time programming to protect against side-channels

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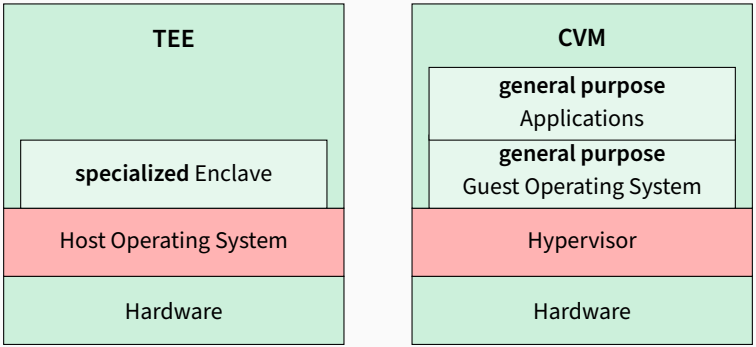

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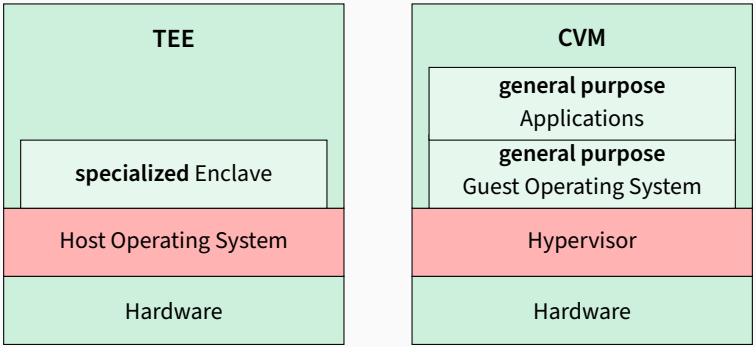

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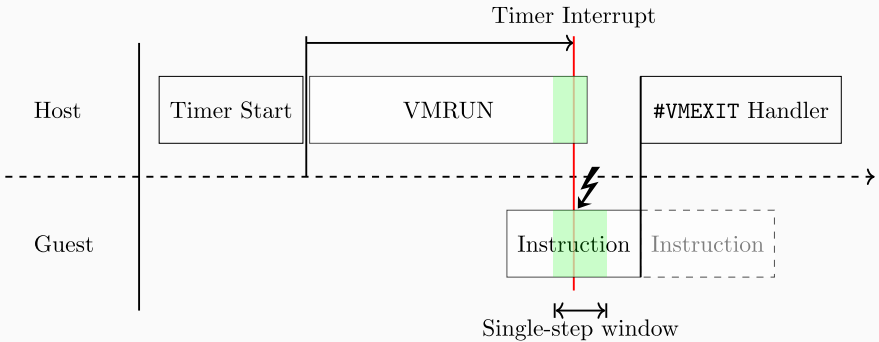
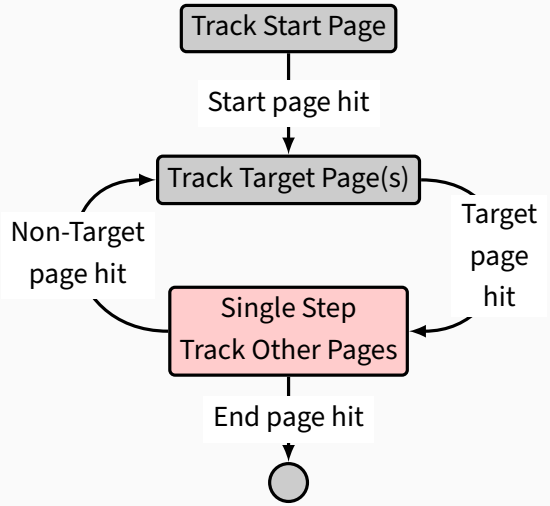
Can we get this information for every single instruction?

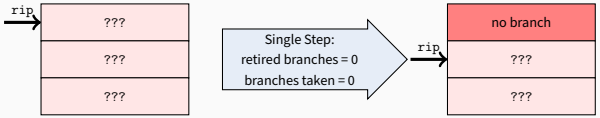
Interrupt-based Single Stepping



Page-Fault Tracking to Start and Stop Recordings



Recovering Control Flow



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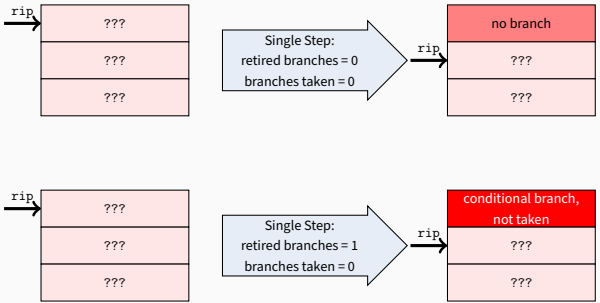

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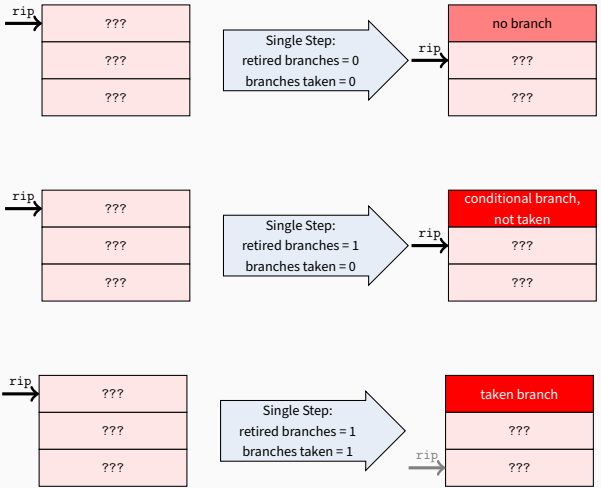
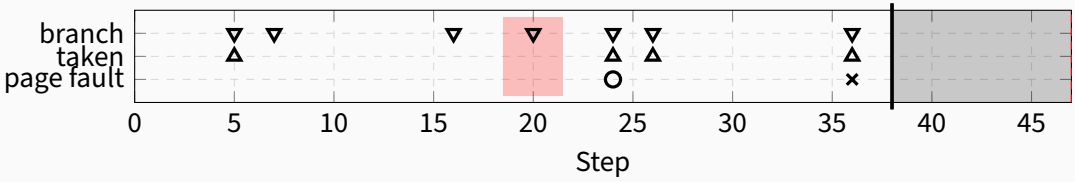


Breaking Mbed TLS Square + Multiply

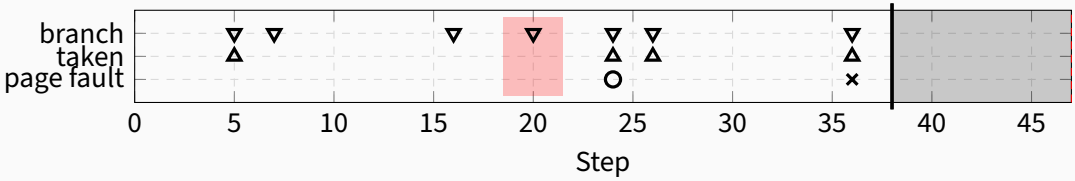

```
for(;;) {
  if (ei == 0 && state == 1) {
    MBEDTLS_MPI_CHK(mpi_select(&WW, W, w_table_used_size, x_index));
    mpi_montmul(&W[x_index], &WW, N, mm, &T);
    continue;
  }
  state = 2;
  MBEDTLS_MPI_CHK(mpi_select(&WW, W, w_table_used_size, x_index));
  mpi_montmul(&W[x_index], &WW, N, mm, &T);
  MBEDTLS_MPI_CHK(mpi_select(&WW, W, w_table_used_size, ei));
  mpi_montmul(&W[x_index], &WW, N, mm, &T);
  state--;
}
```

Breaking Mbed TLS Square + Multiply

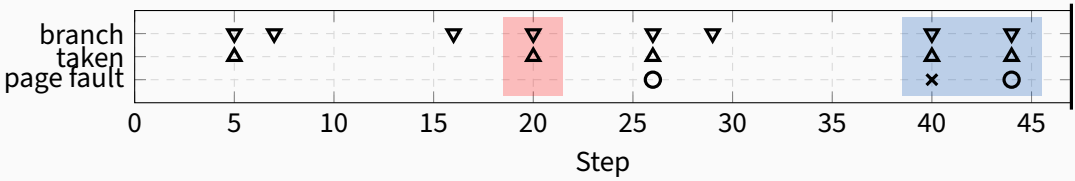


`ei` = 0

Breaking Mbed TLS Square + Multiply



`ei = 0`



`ei = 1`

Breaking Mbed TLS Square + Multiply: Results

Secret recovered:	Full RSA-4096 private key
Average attack runtime:	≈ 7 min
Bit error rate:	$0\,\%$
Success rate:	$100\,\%$

$(n = 10)$

Recovering TOTPs (memcmp-style)

```
COTPRESULT totp_compare(OTPData* data, const char* key,
    int64_t offset, uint64_t for_time)
{
  char time_str[data->digits+1];
  memset(time_str, 0, data->digits+1);
  if (totp_at(data, for_time, offset, time_str) == 0)
    return OTP_ERROR;
  for (size_t i=0; i<data->digits; i++) {
    if (key[i] != time_str[i])
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```

Guess TOTP digit-by-digit, with at most 60 attempts, instead of 1 000 000

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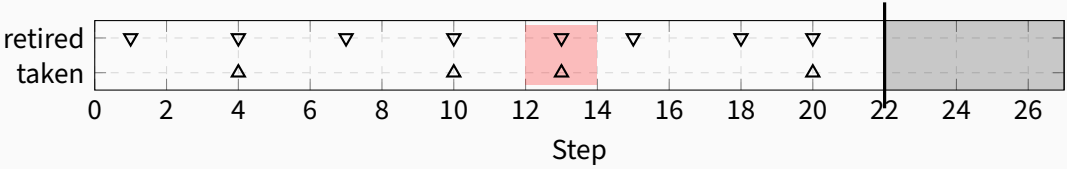

2 correct digits

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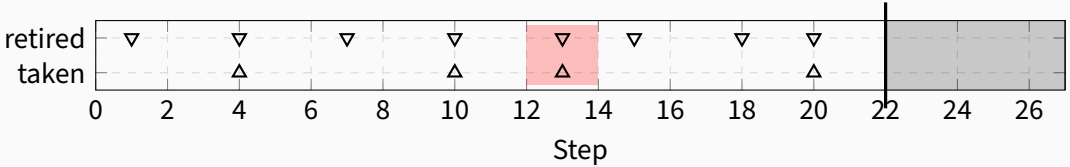

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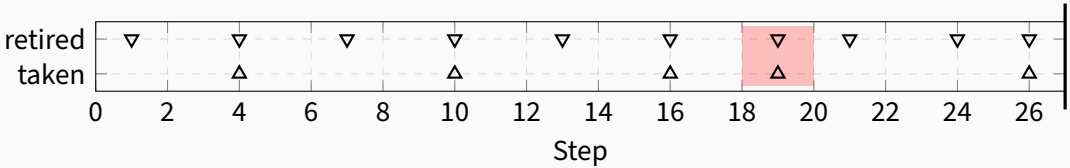

3 correct digits

Recovering TOTPs (memcmp-style): Results

Secret recovered:	6-digit TOTP token
Average attack runtime:	18.14 s
Byte error rate:	0 %
Success rate:	100 %

($n = 50$)

Stealing TOTP secret keys (base32 decoder)

```
static const char OTP_DEFAULT_BASE32_CHARS[32] = { 'A','B','C',... };
COTPRESULT otp_byte_secret(OTPData* data, char* out_str)
{
  for (size_t i = 0; i < num_blocks; i++) {
    unsigned int block_values[8] = { 0 };
    for (int j = 0; j < 8; j++) {
      char c = data->base32_secret[i * 8 + j];
      for (int k = 0; k < 32; k++) {
        if (c == OTP_DEFAULT_BASE32_CHARS[k]) {
          block_values[j] = k;
          break;
        }
      }
    }
  }
}
```

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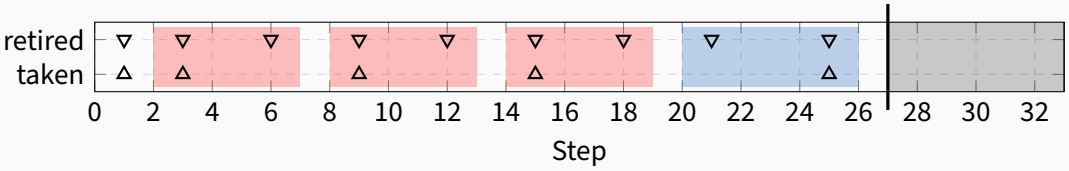
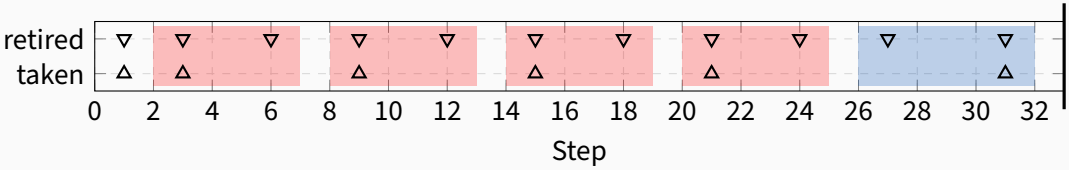


Base32 character is `D`



Base32 character is `E`

Stealing TOTP secret keys (base32 decoder): Results

Secret recovered:	16 base32 character TOTP secret key
Average attack runtime:	< 1 s
Byte error rate:	0 %
Success rate:	86 %
	($n = 86$)

Divide-and-Surrender-style Attack on HQC


```
for(size_t i=0; i<75; ++i)
  tmp[i] = i + rand_u32[i] % (17669U - i);
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- `rand_u32[i] < 512 * (17669-i)` $\rightarrow$ 7 cycles; otherwise 8 cycles

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- Observable via **Div Cycles Busy** performance counter
- **Sufficient to build plaintext-checking oracle**

Acknowledgments

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