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Point Intervention: Improving ACVP Test Vector Generation Through Human Assisted Fuzzing

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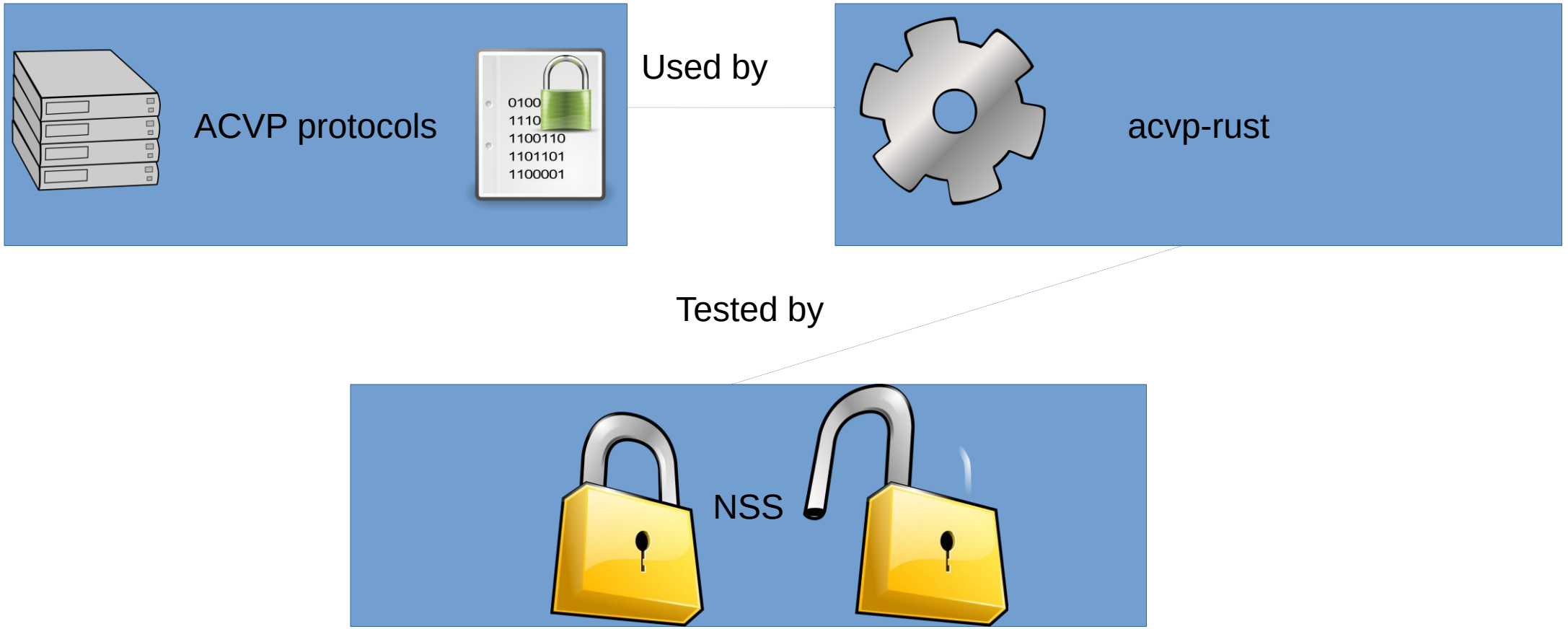
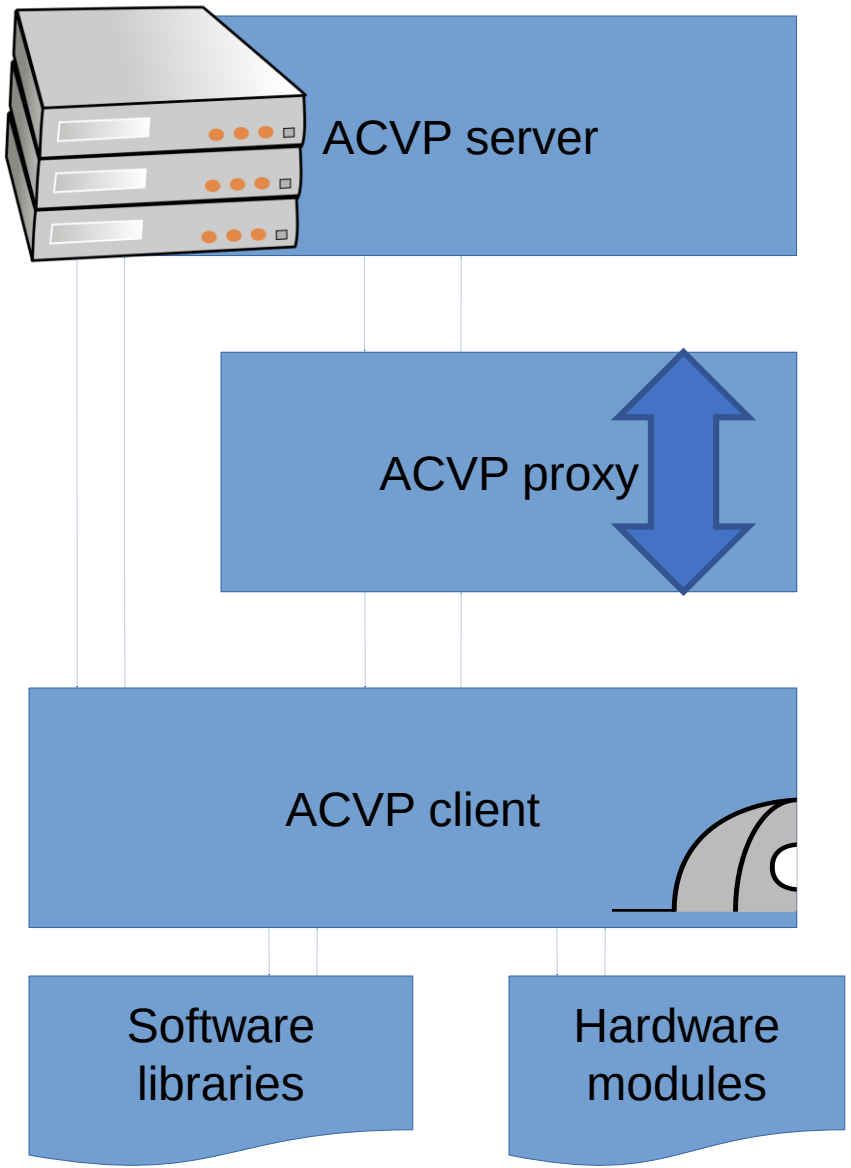
Outline

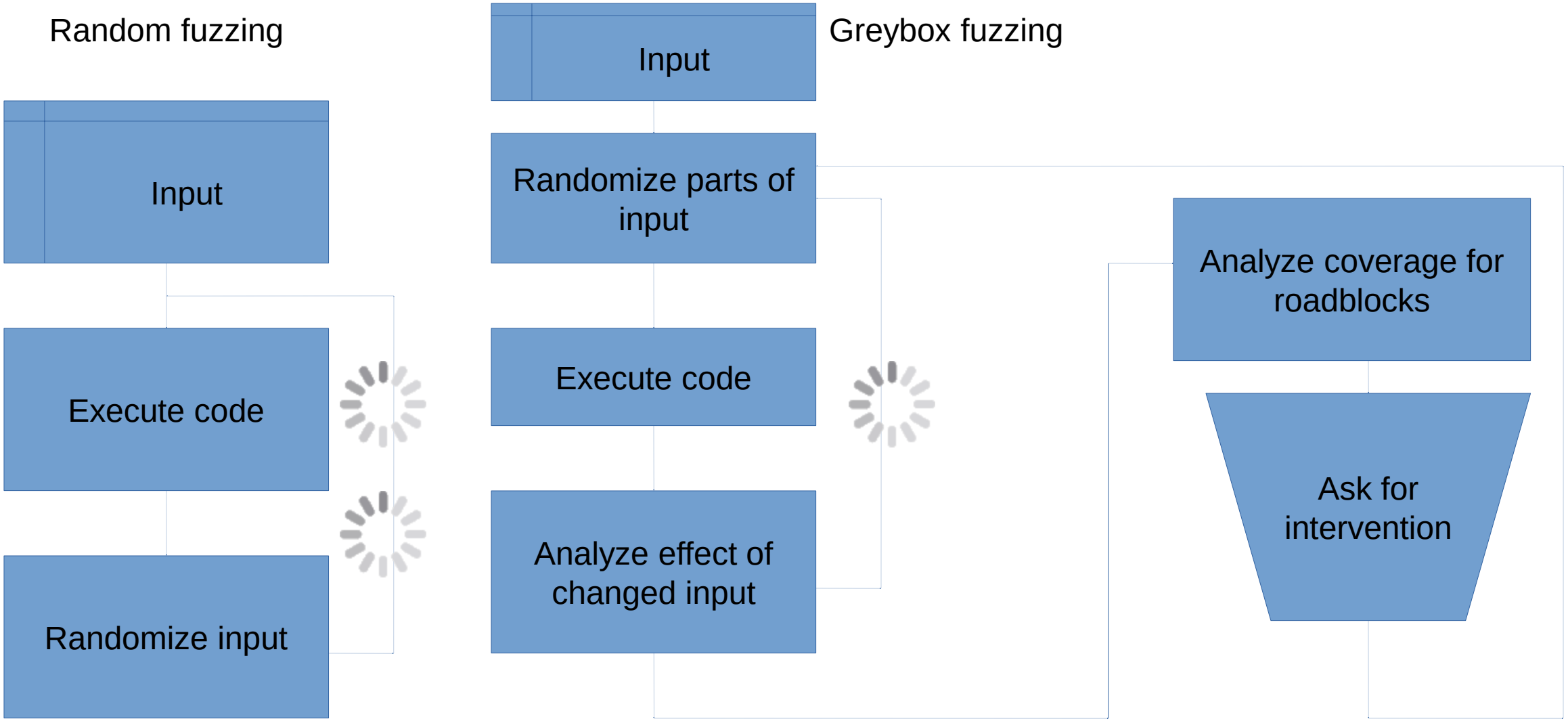


ACVP




```
{
  "vsId": 805548,
  "algorithm": "ACVP-AES-GCM",
  "revision": "1.0",
  "isSample": true,
  "testGroups": [{
    "tgId": 1,
    "testType": "AFT",
    "direction": "encrypt",
    "keyLen": 128,
    "ivLen": 96,
    "ivGen": "external",
    "ivGenMode": "8.2.1",
    "payloadLen": 256,
    "aadLen": 120,
    "tagLen": 104,
    "tests": [{
      "tcId": 1,
      "pt": "28E3FB...9809",
      "key": "C19A...AD2",
      "aad": "E9FB...1B",
      "iv": "C4...DEFB"
    }]
  }]
}
```

Fuzzing schemes



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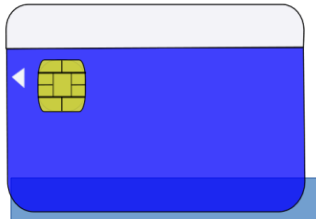
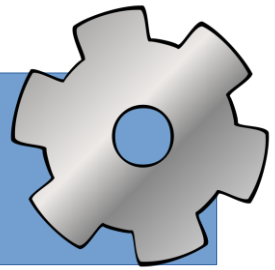
the framework



Cryptographic module(s)

acvp-rust



Fuzzed test corpus and annotated output

Guided human intervention

Improved corpus in ACVP format

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Human intervention scheme

```
1336
1337  166   hash = HASH_GetRawHashObject(hashAlg);
1338  166   dbMaskLen = emLen - hash->length - 1;
1339
1340        /* Step 3 + 4 */
1341  166   if ((emLen < (hash->length + salt
1342  166       (em[emLen - 1] != 0xbc)) {
1343  166       PORT_SetError(SEC_ERROR_BAD_SIGNATURE);
1344  166       return SECFailure;
1345  166   }
1346
1347        /* Step 6 */
1348    0   zeroBits = 8 * emLen - emBits;
1349    0   if (em[0] >> (8 - zeroBits)) {
1350    0       PORT_SetError(SEC_ERROR_BAD_SIGNATURE);
1351    0       return SECFailure;
1352    0   }
1353
```

```
1  let sane_modulus = bool::arbitrary(u)?;
2  let modulus = if sane_modulus {
3          let min_size = if let Some(min_size) =
4                  salt_len.checked_add(hash_alg.digest_len() + 2 /* +1 for possible leading zero */)
5                  min_size
6          } else {
7                  return Err(arbitrary::Error::IncorrectFormat);
8          };
9          let mut modulus =
10             HexString::clamp_length_arbitrary(Some(min_size as usize), None, u)?;
11         if modulus.data[0] == 0 {
12                 modulus.data[0] = 1;
13         };
14         if modulus.data.len() > 0 {
15                 let len = modulus.data.len();
16                 modulus.data[len - 1] = 0xbc;
17         };
18         modulus
19 } else {
20         HexString::arbitrary(u)?
21 };
```

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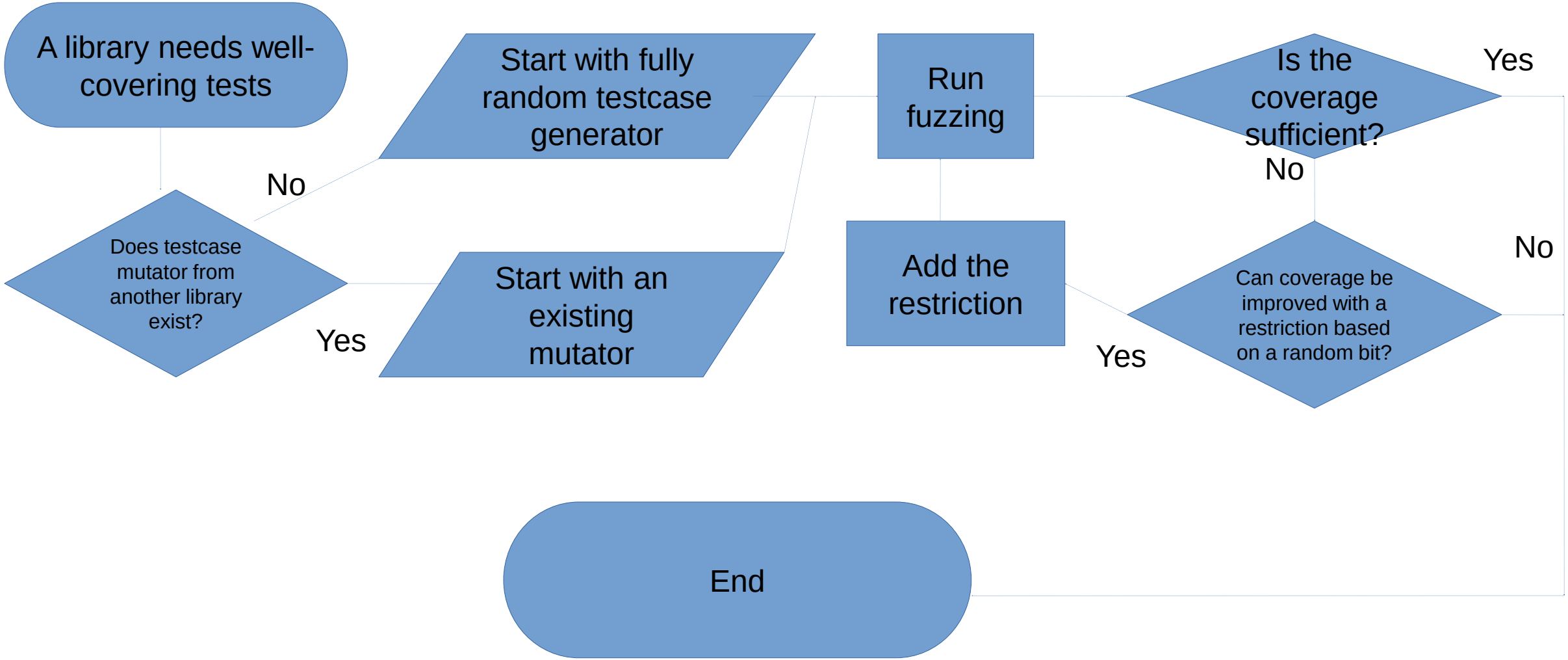
Hybrid fuzzing flowchart



Results with NSS

- We used acvp-rust framework and methodology to search for vulnerability in NSS, a popular cryptographic library used in Firefox, Thunderbird and many other applications

- Using the framework allowed to produce an improved test set, compared to already present fuzzed corpus, improving coverage in critical areas.

- We discovered a bug in RSA code causing access beyond the end of an array under specific conditions. The bug and fix for it were accepted by the NSS maintainers.

- We made many other improvements to NSS preventing possible future issues.

Future Research

- Further automatization
- More subspecifications and improvements to ACVP ones
- Integrating side-channel vulnerability detection tools

Open Science & Reproducible Research

- ACVP-RUST and Results
- Check here: https://gitlab.com/nisec/acvp-rust

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Thanks!

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