# Encrypted ~~SNI~~ Client Hello

draft-ietf-tls-esni-05

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## -04 had some problems

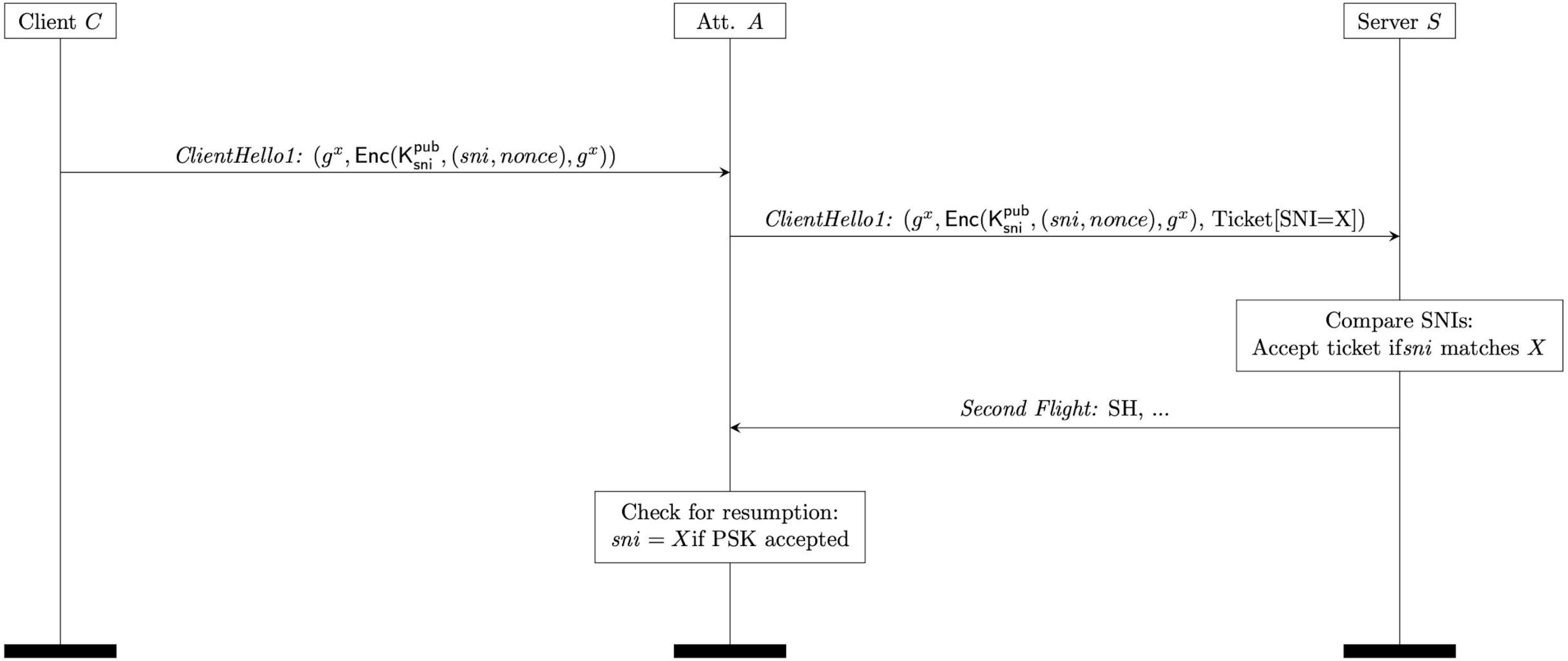
Ticket oracle

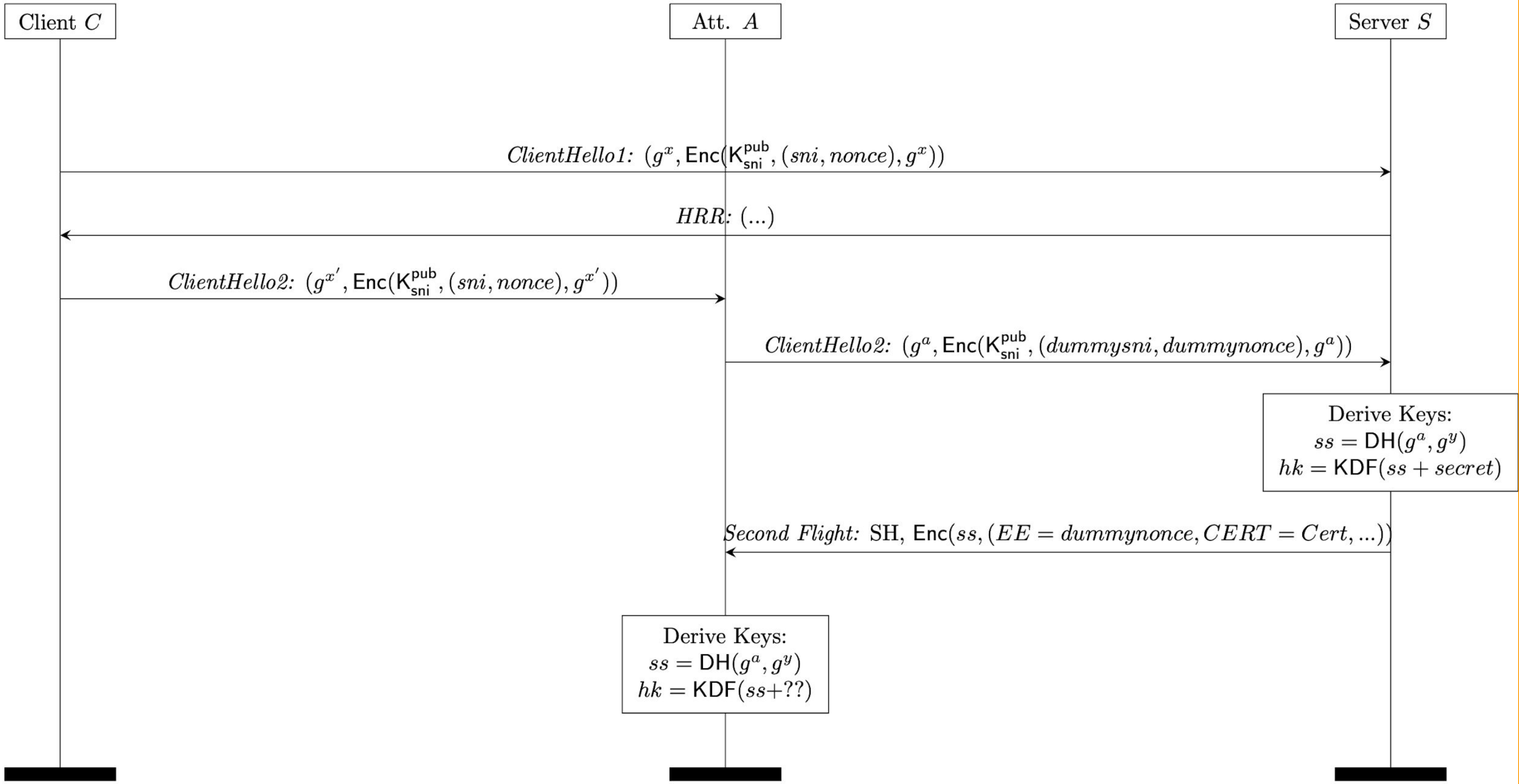
HRR key mismatch

Probing attacks (inconsistent cryptographic configuration)

…

https://github.com/chris-wood/encrypted-sni-model


Client $C$
Att. $A$
Server $S$
*ClientHello1:* $(g^x, \mathsf{Enc}(\mathsf{K}^{\mathsf{pub}}_{\mathsf{sni}}, (sni, nonce), g^x))$
*ClientHello1:* $(g^x, \mathsf{Enc}(\mathsf{K}^{\mathsf{pub}}_{\mathsf{sni}}, (sni, nonce), g^x)$, Ticket[SNI=X])
Compare SNIs:
Accept ticket if $sni$ matches $X$
*Second Flight:* SH, ...
Check for resumption:
$sni = X$ if PSK accepted


Client $C$
Att. $A$
Server $S$
*ClientHello1:* $(g^x, \mathsf{Enc}(\mathsf{K}_{\mathsf{sni}}^{\mathsf{pub}}, (sni, nonce), g^x))$
*HRR:* (...)
*ClientHello2:* $(g^{x'}, \mathsf{Enc}(\mathsf{K}_{\mathsf{sni}}^{\mathsf{pub}}, (sni, nonce), g^{x'}))$
*ClientHello2:* $(g^a, \mathsf{Enc}(\mathsf{K}_{\mathsf{sni}}^{\mathsf{pub}}, (dummysni, dummynonce), g^a))$
Derive Keys:
$ss = \mathsf{DH}(g^a, g^y)$
$hk = \mathsf{KDF}(ss + secret)$
*Second Flight:* SH, $\mathsf{Enc}(ss, (EE = dummynonce, CERT = Cert, ...))$
Derive Keys:
$ss = \mathsf{DH}(g^a, g^y)$
$hk = \mathsf{KDF}(ss + ??)$

## Root Cause(s)

Lack of proper bindings:

- Between ESNI and CH contents, including resumption PSKs
- Between CH1 and CH2 in the event of HRR
- Between ESNI and remaining handshake secrets

**Proposed solution**:

- Encrypt (tunnel) the entire ClientHello
- Tie CH2 to CH1 for HRR
- Make handshake secrets depend on ESNI block

## Probably Wrong Strawman Tunnelling Proposal

```
struct {
    CipherSuite suite;           // for ESNI
    KeyShareEntry key_share;   // for ESNI
    opaque record_digest<0..2^16-1>;
    opaque ch1_binder<0..256>;       // TBD
    opaque encrypted_ch<0..2^16-1>; // ClientHelloInner
} ClientEncryptedCH;
```

## What is the transcript?

ESNI Accepted → `ClientHelloInner`

ESNI Rejected (fallback) → `ClientHelloOuter`

- This includes the encrypted `ClientHelloInner`

How does the client know what happened?

- Trial decryption

## How does this help?

Entire `ClientHelloInner` is protected

- Prevents changing any piece

CH2 contains a hash of CH1

- Prevents mix-and-match between CH1 and CH2

Handshake secrets depend on ESNI block

- Option 1: ESNI Nonce is part of transcript, and so affects handshake keys
- Option 2: Explicitly inject ESNI-based keys into key schedule

## Isn't this really huge?

`ClientHelloOuter` is roughly 2X the normal size

- Includes an ordinary ClientHello
- Real problem with post-quantum key exchange

**Solution:** "hoist" extensions from `ClientHelloInner` into `ClientHelloOuter`

- Client removes duplicate values from `ClientHelloInner` when sending
- Client-facing server restores them after decrypting ESNI block
- Important they be authenticated as part of ESNI block
  - E.g., Include a hash of the value of the extensions

## Open Issue: Handshake Keys

Handshake keys must be depend on ESNI block (prevent HRR oracles)

**Option 1**: Nonce as part of transcript

- Maybe allows unmodified back-end server
- Requires more assumptions about transcript secrecy and the nature of HKDF

**Option 2**: Inject a key (no nonce) derived from ESNI key into the key schedule

- Requires modifying back-end server
- Seems to rely on simpler assumptions

**Proposed resolution:** publish draft-06 with Option 1 while we model both. Follow up on list.

## Bundle Multiple ESNIConfigs (PR #200)

**Problem:**

- Currently one `ESNIConfig` per HTTPSVC.
- What if the HTTPSVC record you pick has an `ESNIConfig` version you don't support?

**Solution:** Bundle all your `ESNIConfig` objects into `ESNIConfigs`, put that in HTTPSVC

## Flatten ESNIConfig (PR #201)

**Problem:**

- `ESNIConfig` contains a list of parameters plus multiple `KeyShares`
- David Benjamin suggests flattening so you have one `KeyShare` per `ESNIConfig`
    - More keys → more `ESNIConfigs`

**Upside:** Implementation simplicity (?)
**Downside:** Duplication

**Proposal:** Discuss.

## Next steps

Publish -06

Adopt HPKE for ClientHello encryption (?)

Resolve DNS extensibility PRs #200 and #201

Rename document? Encrypted ClientHello → ECHO

**Start WGLC in early 2020**