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D. Benjamin
Google, LLC.
C. Wood
Apple, Inc.
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Importing External PSKs for TLS
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Abstract

This document describes an interface for importing external PSK (Pre-Shared Key) into TLS 1.3.

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[1.](#) Introduction

TLS 1.3 [[RFC8446](#)] supports pre-shared key (PSK) authentication, wherein PSKs can be established via session tickets from prior connections or externally via some out-of-band mechanism. The protocol mandates that each PSK only be used with a single hash function. This was done to simplify protocol analysis. TLS 1.2 [[RFC5246](#)], in contrast, has no such requirement, as a PSK may be used with any hash algorithm and the TLS 1.2 PRF. This means that external PSKs could possibly be re-used in two different contexts with the same hash functions during key derivation. Moreover, it requires external PSKs to be provisioned for specific hash functions.

To mitigate these problems, external PSKs can be bound to a specific hash function when used in TLS 1.3, even if they are associated with a different KDF (and hash function) when provisioned. This document specifies an interface by which external PSKs may be imported for use in a TLS 1.3 connection to achieve this goal. In particular, it describes how KDF-bound PSKs can be differentiated by different hash algorithms to produce a set of candidate PSKs, each of which are bound to a specific hash function. This expands what would normally have been a single PSK identity into a set of PSK identities. However, it requires no change to the TLS 1.3 key schedule.

[2.](#) Conventions and Definitions

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP

14 [[RFC2119](#)] [[RFC8174](#)] when, and only when, they appear in all capitals, as shown here.

[3.](#) Overview

Intuitively, key importers mirror the concept of key exporters in TLS in that they diversify a key based on some contextual information before use in a connection. In contrast to key exporters, wherein differentiation is done via an explicit label and context string, the key importer defined herein uses a label and set of hash algorithms to differentiate an external PSK into one or more PSKs for use.

Imported keys do not require negotiation for use, as a client and server will not agree upon identities if not imported correctly. Thus, importers induce no protocol changes with the exception of expanding the set of PSK identities sent on the wire. Endpoints may incrementally deploy PSK importer support by offering non-imported keys for TLS versions prior to TLS 1.3. (Negotiation and use of imported PSKs requires both endpoints support the importer API described herein.)

[3.1.](#) Terminology

- o External PSK (EPSK): A PSK established or provisioned out-of-band, i.e., not from a TLS connection, which is a tuple of (Base Key, External Identity, KDF). The associated KDF (and hash function) may be undefined.
- o Base Key: The secret value of an EPSK.
- o External Identity: The identity of an EPSK.
- o Imported Identity: The identity of a PSK as sent on the wire.

[4.](#) Key Import

A key importer takes as input an EPSK with external identity 'external_identity' and base key 'epsk', as defined in [Section 3.1](#), along with an optional label, and transforms it into a set of PSKs and imported identities for use in a connection based on supported HashAlgorithms. In particular, for each supported HashAlgorithm 'hash', the importer constructs an ImportedIdentity structure as follows:

```
struct {
    opaque external_identity<1...2^16-1>;
    opaque label<0..2^8-1>;
    HashAlgorithm hash;
} ImportedIdentity;
```

[[TODO: An alternative design might combine label and hash into the same field so that future protocols which don't have a notion of HashAlgorithm don't need this field.]]

ImportedIdentity.label MUST be bound to the protocol for which the key is imported. Thus, TLS 1.3 and QUICv1 [[I-D.ietf-quic-transport](#)] MUST use "tls13" as the label. Similarly, TLS 1.2 and all prior TLS versions should use "tls12" as ImportedIdentity.label, as well as SHA256 as ImportedIdentity.hash. Note that this means future versions of TLS will increase the number of PSKs derived from an external PSK.

A unique and imported PSK (IPSK) with base key 'ipskx' bound to this identity is then computed as follows:

```
epskx = HKDF-Extract(0, epsk)
ipskx = HKDF-Expand-Label(epskx, "derived psk",
                          Hash(ImportedIdentity), Hash.length)
```

[[TODO: The length of ipskx MUST match that of the corresponding and supported ciphersuites.]]

The hash function used for HKDF [[RFC5869](#)] is that which is associated

with the external PSK. It is not bound to `ImportedIdentity.hash`. If no hash function is specified, SHA-256 MUST be used. Differentiating `epsk` by `ImportedIdentity.hash` ensures that each imported PSK is only used with at most one hash function, thus satisfying the requirements in [RFC8446]. Endpoints MUST import and derive an `ipsk` for each hash function used by each ciphersuite they support. For example, importing a key for `TLS_AES_128_GCM_SHA256` and `TLS_AES_256_GCM_SHA384` would yield two PSKs, one for SHA256 and another for SHA384. In contrast, if `TLS_AES_128_GCM_SHA256` and `TLS_CHACHA20_POLY1305_SHA256` are supported, only one derived key is necessary.

The resulting IPSK base key '`ipskx`' is then used as the binder key in TLS 1.3 with identity `ImportedIdentity`. With knowledge of the supported hash functions, one may import PSKs before the start of a connection.

EPSKs may be imported for early data use if they are bound to protocol settings and configurations that would otherwise be required for early data with normal (ticket-based PSK) resumption. Minimally,

that means ALPN, QUIC transport settings, etc., must be provisioned alongside these EPSKs.

5. Label Values

For clarity, the following table specifies PSK importer labels for varying instances of the TLS handshake.

Protocol	Label
TLS 1.3 [RFC8446]	"tls13"
QUICv1 [I-D.ietf-quic-transport]	"tls13"
TLS 1.2 [RFC5246]	"tls12"
DTLS 1.2 [RFC6347]	"dtls12"
DTLS 1.3 [I-D.ietf-tls-dtls13]	"dtls13"

[6.](#) Deprecating Hash Functions

If a client or server wish to deprecate a hash function and no longer use it for TLS 1.3, they may remove this hash function from the set of hashes used during while importing keys. This does not affect the KDF operation used to derive concrete PSKs.

[7.](#) Backwards Compatibility and Incremental Deployment

Recall that TLS 1.2 permits computing the TLS PRF with any hash algorithm and PSK. Thus, an external PSK may be used with the same KDF (and underlying HMAC hash algorithm) as TLS 1.3 with importers. However, critically, the derived PSK will not be the same since the importer differentiates the PSK via the identity and hash function. Thus, PSKs imported for TLS 1.3 are distinct from those used in TLS 1.2, and thereby avoid cross-protocol collisions. Note that this does not preclude endpoints from using non-imported PSKs for TLS 1.2. Indeed, this is necessary for incremental deployment.

[8.](#) Security Considerations

This is a WIP draft and has not yet seen significant security analysis.

[9.](#) Privacy Considerations

DISCLAIMER: This section contains a sketch of a design for protecting external PSK identities. It is not meant to be implementable as written.

External PSK identities are typically static by design so that endpoints may use them to lookup keying material. For some systems and use cases, this identity may become a persistent tracking identifier. One mitigation to this problem is encryption. Future drafts may specify a way for encrypting PSK identities using a mechanism similar to that of the Encrypted SNI proposal [[I-D.ietf-tls-esni](#)]. Another approach is to replace the identity with an unpredictable or "obfuscated" value derived from the corresponding PSK. One such proposal, derived from a design outlined

in [[I-D.ietf-dnssd-privacy](#)], is as follows. Let `ipskx` be the imported PSK with identity `ImportedIdentity`, and `N` be a unique nonce of length equal to that of `ImportedIdentity.hash`. With these values, construct the following "obfuscated" identity:

```
struct {
    opaque nonce[hash.length];
    opaque obfuscated_identity<1..2^16-1>;
    HashAlgorithm hash;
} ObfuscatedIdentity;
```

`ObfuscatedIdentity.nonce` carries `N`,
`ObfuscatedIdentity.obfuscated_identity` carries `HMAC(ipskx, N)`, where `HMAC` is computed with `ImportedIdentity.hash`, and `ObfuscatedIdentity.hash` is `ImportedIdentity.hash`.

Upon receipt of such an obfuscated identity, a peer must lookup the corresponding PSK by exhaustively trying to compute `ObfuscatedIdentity.obfuscated_identity` using `ObfuscatedIdentity.nonce` and each of its known imported PSKs. If `N` is chosen in a predictable fashion, e.g., as a timestamp, it may be possible for peers to precompute these obfuscated identities to ease the burden of trial decryption.

[10.](#) IANA Considerations

This document makes no IANA requests.

[11.](#) References

[11.1.](#) Normative References

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[Appendix A](#). Acknowledgements

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Authors' Addresses

David Benjamin
Google, LLC.

Email: davidben@google.com

Christopher A. Wood
Apple, Inc.

Email: cawood@apple.com