A MODEST PROPOSAL FOR HPKE

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IETF 113, March 2022
HPKE does not work well for some use cases

• Serialization of NIST curves is more than twice as long as it needs to be
  x-coordinate is all that’s needed (“compact output” per RFC 6090)

  p256 with SEC uncompressed serialization:

  041e9081e36299e5d4c7c30f3eeae1b4ccef32b9953f6cd3cf97e3fb76cd7e6791a0e8ae893612305ae4f32b2f9f0219eced8fabd96ee07c063f802b43731471

  p256 with RFC 6090 compact output serialization:

  1e9081e36299e5d4c7c30f3eeae1b4ccef32b9953f6cd3cf97e3fb76cd7e6791

  Simple solution: new KEM assignments for NIST curves using compact output

• Assumes guaranteed, in-order delivery of frames, fails on lossy networks
  Management of AEAD nonce is entirely in the HPKE context
  - No way to know which nonce was used with a given ciphertext
  - No way to synchronize after loss/reorder
  - No way to even notice except everything suddenly stops working
  - Packet loss or packet reordering is tragic with HPKE

  The Internet does not provide guaranteed, in-order delivery of packets
Addressing lossy networks

• Use a deterministic AEAD mode– no nonce needed
  - To keep the IND-CCA2 assurance of HPKE, this must only be used when the plaintext is idempotent or contains some probabilism that a nonce normally would’ve provided.
  - Rogaway and Shrimpton paper on SIV* has a security proof for this type of “key wrapping”.

• Otherwise, use existing AEAD mode and do a rolling replay window ala RFC 2401
  - Window is a bitmap of received packets, packets can be skipped and received out of order.
  - Replays are dropped and valid packets get marked as received.
  - Valid packets whose sequence number is greater than the window advance the window.
  - Packets that are “too old” will be dropped.

This requires the sequence number (but not the secret nonce to which it is XOR’d) to be exported as part of the ciphertext– first 4 octets are the sequence number– data that is already exposed to a passive attacker who can count.

Proposal: **Add** the following…

Compact representation
- New KEMs for NIST curves
- Compact representation (RFC 6090)

Deterministic Authenticated Encryption
- Support for AES-SIV (RFC 5297)
- No nonce generated/used in HPKE context

Option to set in context to use/support replay window
- Both sides must agree
- Agreement in same way everything else is agreed on
Internet-Draft:
draft-harkins-cfrg-dnhpke-01

Source code: Running Code!
https://github.com/danharkins/hpke-wrap

- Fully compliant with RFC 9180
- Supports compact representation with new KEM values*
- Supports deterministic authenticated encryption ciphers*
- Supports setting a flag to use a rolling replay window for lossy networks
- Complete test vectors (based on the latest version of HPKE test vectors) for new KEMs and ciphers

* Took the liberty of stealing some values reserved to IANA for test vector generation
Adopt as a CFRG Work Item?