### IEEE P802.11 Wireless LANs

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| --- | --- | --- | --- | --- |
| Protected Password Identifiers for Privacy | | | | |
| Date: 2021-01-10 | | | | |
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Abstract

This submission proposes an efficient way to provide privacy protections to SAE password identifiers.

TGm received a comment regarding password identifiers and the proposal was to get rid of them as they can be used to track users. While, technically, that is correct, the way they are proposed for use is to provide multiple groups of users all on a single SSID. Today that is accomplished by spinning up multiple SSIDs, each with its own password. It should be noted that cleartext password identifiers do not pose any additional privacy concerns as an observer would merely know that a STA is a member of the identified group, which is what it learns today by identifying the STA as a member of “those who know the password for <SSID>.”

Instead of doing away with them, it is proposed to actually provide a way of providing a STA with a pseudonymous, and stateless identity that can be used for one-time access and a way to obtain a new pseudonym for use with a single subsequent connection. This will actually address any privacy concern that could be claimed.

The idea is that the Authenticator maintains a secret which is uses to encrypt the plaintext identifier to produce a pseudonym which the Authenticator is able to decrypt. STAs then add the pseudonym to their network profile and use that, instead of the plaintext identifier, on subsequent connections. Each new connection will result in the Authenticator generating a new pseudonym for the STA which is overwrites in its network profile for the next connection.

This scheme has the following properties:

* A passive attacker cannot determine a protected identity;
* Identifiers are protected against active attack insofar as SAE is resistant to active attack;
* A passive attacker cannot connect protected identities across SAE protocol runs to generate PII;
* Password identifiers can be arbitrarily padded to foil passive traffic analysis;
* Protected identities are secure under a birthday bound of 232 encryptions;
* An attacker cannot tamper with or substitute identifiers to connect distinct runs of SAE;
* An AP needs to only manage a single symmetric secret;
* APs in an ESS can share the single symmetric secret (in an out of band, out of scope manner);
* APs can use the same symmetric secret to protect all groups in the ESS that use password identifiers;
* Identities are protected against members of the same group;
* The interface for password identifiers on a STA is unchanged;
* The overhead is minimal—25 octets plus padding;
* Uses symmetric cryptography for speed and DOS resistance;
* Protected password identifiers in a mesh is supported.

Proposed change:

*Instruct the editor to modify section 9.3.3.11 as indicated:*

**9.3.3.11 Authentication frame format**

**Table 9-42—Authentication frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| 22 | Password Identifier | The Password Identifier element is optionally present in certain Authentication frames as defined in Table 9-43 (Presence of fields and elements in Authentication frames) |
| 23 | Rejected Groups | The Rejected Groups element is present only in certain Authentication frames as defined in Table 9-43 (Presence of fields and elements in Authentication frames). |
| 24 | Anti-Clogging Token Container | The Anti-Clogging Token Container element is present only in certain Authentication frames as defined in Table 9-43 (Presence of fields and elements in Authentication frames). |
| 25 | Protected Password Identifier | The Protected Password Identifier element is optionally present in certain Authentication frames as defined in Table 9-43 (Presence of fields and elements in Authentication frames). |
| Last | Vendor Specific | One or more Vendor Specific elements are optionally present. These elements follow all other elements. |

**Table 9-43—Presence of fields and elements in Authentication frames**

|  |  |  |  |
| --- | --- | --- | --- |
| Authentication algorithm | Authentication transaction sequence number | Status code | Presence of fields and elements from order 4 onwards |
| SAE | 1 | Any | The Scalar field is present if the Status Code field is zero or 126.  The FFE field is present if the Status Code field is zero or 126.  When the hunting-and-pecking method is used to drive the PWE, the Anti-Clogging Token field is present if the Status Code field is ANTI\_CLOGGING\_TOKEN\_REQUIRED or if the Authentication frame is in response to a previous rejection with the Status Code field equal to ANTI\_CLOGGING\_TOKEN\_REQUIRED.  The Finite Cyclic Group field is present if the Status Code field is zero, ANTI\_CLOGGING\_TOKEN\_REQUIRED, 77, or 126.  The Password Identifier element is optionally present if the Status Code field is zero, 123, or 126, and the Protected Password Identifier element is not present.  The Rejected Groups element is present if the Status Code field is 126.  When the hash-to-element method is used to derive the PWE, the Anti-Clogging Token Container  element is present if the Status Code field is ANTI\_CLOGGING\_TOKEN\_REQUIRED or if the Authentication frame is in response to a previous rejection with the Status Code field equal to ANTI\_CLOGGING\_TOKEN\_REQUIRED.  The Protected Password Identifier element is optionally present if the Status Code field is zero, 123, or 126, and the Password Identifier field is not present. |

*Instruct the editor to modify table 9-94 as indicated, obtain a new identifier for the new element, and replace <ANA-1> with that number.*

**9.4.2 Elements**

**9.4.2.1 General**

**Table 9-94—Element IDs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Element ID** | **Element ID Extension** | **Extensible** | **Fragmentable** |
| Anti-Clogging Token Container (see 9.4.2.247 (Anti-Clogging Token Container element)) | 255 | 93 | No | No |
| Protected Password Identifier element (see 9.4.2.X (Protected Password Identifier element)) | 255 | <ANA-1> | No | No |
| Reserved | 255 | <ANA-1> + 1-255 |  |  |

*Instruct the editor to create a new section as below, replacing X with the appropriate number and assigning the figure number appropriately:*

**9.4.2.X Protected Password Identifier element**

The Protected Password Identifier element is used to convey a password identifier duing an authentication exchange in a manner that will hide the actual value from attackers. The format of the Protected Password Identifier element is shown in Figure 9-XYZ (Protected Identifier element format).

|  |  |  |  |
| --- | --- | --- | --- |
| Element ID | Length | Element ID  Extension | Protected Identifier |

Octets: 1 1 1 variable

**Figure 9-XYZ—Protected Identifier element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1 (General).

The Protected Identifier field contains an opaque variable-length string.

*Instruct the editor to modify section 9.6.15.3.2 as indicated:*

**9.6.15.3.2 Mesh Peering Confirm frame details**

**Table 9-436—Mesh Peering Confirm frame Action field format**

|  |  |  |
| --- | --- | --- |
| Order | Information | Notes |
| 16 | VHT Operation | The VHT Operation element is present when dot11VHTOperationImplemented is true |
| 17 | Operating Mode Notification | The Operating Mode Notification element is optionally present if dot11OperatingNotificationImplemented is true |
| 18 | Protected Password Identifier | The Protected Password Identifier element is optionally present if a mesh STA wishes to provide a protected password identifier to a peer mesh STA |

The OCI and the PPI elements appear prior to the MIC element in the Mesh Peering Open frame, and as part of the input AAD are authenticated by the MIC element (see 14.5 (Authenticated mesh peering exchange (AMPE))).

*Instruct the editor to modify section 12.4.3 as indicated:*

**12.4.3 Representation of passwords and password identifiers**

In an infrastructure BSS for which an SAE AKM is indicated, the AP shall set the SAE Password Identifiers In Use subfield of the Extended Capabilities field of the Extended Capabilities element to 1 if any entry in the dot11RSNAConfigPasswordV alueTable has a non-NULL dot11RSNAConfigPasswordIdentifier, and shall set it to 0 otherwise. Similarly, an AP shall set the SAE Password Identifiers Used Exclusively subfield of the Extended Capabilities field of the Extended Capabilities element to 1 if every entry in the dot11RSNAConfigPasswordValueTable has a non- NULL dot11RSNAConfigPasswordIdentifier and shall set it to 0 otherwise.

After an initial connection with a plaintext password identifier, an AP (in an infrastructure BSS) or a mesh STA (in a mesh) can provide an encrypted identifier to the STA (infrastructure) or peer mesh STA (mesh), respectively, to use in a subsequent connection. The password identifier from the dot11RSNAConfigPasswordValueTable remains unchanged but the AP, or mesh STA, encrypts the identifier and sends the encrypted identifier to the STA (infrastructure) during the 4-way Handshake or peer mesh STA (mesh) during the AMPE. Each time an encrypted identifier is used in a subsequent SAE authentication it should be changed for the next authentication using the technique described here such that each encrypted identifier is used with only one run of the SAE protocol.

1. An AP or mesh STA that supports protected password identifiers shall generate a secret to use with AES-SIV (either a 256-bit or 512-bit key), referred to as *pk* below. The encrypted identifier shall be generated as follows:An 8 octet random string, denoted here *s*, shall be generated;
2. The plaintext identifier shall be pre-pended with 1 or more octets of padding, the first of which indicates the length of the pad—e.g. if there are 4 octets of padding then the sequence would be 4-0-0-0, if there is only one octet of padding the sequence would simply be 1—the length of the pad should vary each time an encrypted identifier is generated;
3. A ciphertext, *c*, is generated using AES-SIV with *s* as the AAD, *pk* as the key, and the padded password identifier as the plaintext;
4. The encrypted identifier is the concatenation of *s* and *c*.

The encrypted identifier is provided to a STA in an infrastructure BSS in message 3 of the 4 Way Handshake in the PPI KDE (see 12.7.3), and provided to a peer mesh STA in a mesh in a Mesh Peering Confirm frame (see 14.5.5.3.1) in the Protected Password Identifier element (see 9.4.2.X).

A STA or mesh STA that receives an encrypted identifier shall retain it and shall use it in a subsequent SAE authentication to another AP in the ESS (infrastructure) or another mesh STA (mesh).

When a STA or mesh STA uses an encrypted identifier in SAE it shall pass it in the Protected Password Identity element in an SAE Commit message. When the Protected Password Identifier element is present in an SAE Commit message, the Password Identifier element shall not be present.

When an AP or mesh STA receives a Protected Password Identifier element in an SAE Commit message it shall decrypt the identity as follows:

1. The encrypted identifier is extracted from the Protected Password Identifier element, the first 8 octets are assigned the value *s* and the remainder is *c*;
2. A plaintext, *p*, is generated by decrypting using AES-SIV with *s* as the AAD, *pk* as the key and *c* as the ciphertext;
3. The length of the pad, *t*, is determined from first octet of p;
4. The first *t* octets of *p* are removed and the remainder is the decrypted Password Identifier.
5. If AES-SIV decryption fails, SAE authentication fails.

*Instruct the editor to modify section 12.4.4.2.3 as indicated:*

**12.4.4.2.3 Hash-to-curve generation of the password element with ECC groups**

The SSWU method produces two values, x1, and x2, at least one of which will represent an abscissa of a point on the curve. If x1 is the abscissa, then x1 becomes the x-coordinate otherwise x2 becomes the x-coordinate. The equation of the curve with the x-coordinate produces the square of the y-coordinate which is recovered by taking the square root. The two possible results of the square root are discriminated by checking its least significant bit with the least significant bit of u. The result is a point on the curve.

The *identifier* used in the calculations above shall be the value extracted from the SAE Commit message. If protected password identifiers are used, the identifier in the calculations above shall be the encrypted value from the Protected Identifier field of the Protected Password Identifier element, otherwise it shall be the value from the Identifier field of the Password Identifier element.

*Instruct the editor to modify section 12.4.4.3.3 as indicated:*

This secret PT is stored until needed to generate a session specific(#4663) PWE (see 12.4.5.2 (PWE and secret generation)).

The *identifier* used in the calculations above shall be the value extracted from the SAE Commit message. If protected password identifiers are used, the identifier in the calculations above shall be the encrypted value from the Protected Identifier field of the Protected Password Identifier element, otherwise it shall be the value from the Identifier field of the Password Identifier element.

*Instruct the editor to modify section 12.4.5.4 as indicated:*

**12.4.5.4 Processing of a peer’s SAE Commit message**

If the peer’s SAE Commit message contains a password identifier, the value of that identifier shall be used in construction of the password element (PWE) for this exchange. If the peer’s SAE Commit message contains an encrypted identifier, the encrypted identifier shall be used in construction of the secret element PT for this exchange (see 12.4.4.2.3 (Hash-to-curve generation of the password element with ECC groups) and 12.4.4.3.3 (Direct Generation of the password element with FFC groups). If peer privacy is supported, an encrypted identifier shall be generated from the plaintext password identifier (see 12.4.3 (Representation of passwords and identifiers)) and transmitted to the peer in the 4 Way Handshake (for an Infrastructure BSS) or AMPE (for a mesh STA) after SAE has successfully terminated. If a password identifier, or protected password identifier, is present in the peer’s SAE Commit message and there is no password with the given (decrypted) identifier a STA shall fail authentication.

*Instruct the editor to obtain a new data type from ANA and modify table 12-9 in section 12.7.3 as indicated, replacing <ANA-2> below with the new data type:*

**Table 12-9—KDE selectors**

|  |  |  |
| --- | --- | --- |
| **OUI** | **Data type** | **Meaning** |
| 00-0F-AC | 13 | OCI KDE |
| 00-0F-AC | 14 | BIGTK KDE |
| 00-0F-AC | <ANA-2> | PPI KDE |
| 00-0F-AC | <ANA-2>+1 -255 | Reserved |
| Other OUI or CID | Any | Vendor specific |

*Instruct the editor to append the following to section 12.7.3*

The format of the PPI KDE is shown in Figure 12-AB (PPI KDE).

|  |
| --- |
| PPI |

Octets: (Length – 4)

**Figure 12-AB—PPI KDE format**

The PPI is an opaque string that shall be retained by a STA and used as a Protected Password Identifier with a subsequent SAE authentication to the same ESS with which it is performing the 4-way Handshake.

*Instruct the editor to modify section 14.5.5.3.1 as indicated:*

**14.5.5.3.1 Generating Mesh Peering Confirm frames for AMPE**

In addition to contents for establishing a mesh peering as specified in 14.3.7.1 (Generating Mesh Peering Confirm frames), the Mesh Peering Confirm frame, when used with the AMPE, shall contain the following:

* In the Mesh Peering Management element, the Mesh Peering Protocol Identifier shall be set to 1 “authenticated mesh peering exchange protocol.”
* The RSNE shall be the same as sent in the Mesh Peering Open frame.
* If the PMK used in the AMPE exchange was generated using SAE and the mesh STA wishes to supply the peer mesh STA with a protected identifier, the Protected Password Identifier element shall be present. The Protected Identifier field shall be constructed per 12.4.3 (Representation of passwords and password identifiers).
* In the Authenticated Mesh Peering Exchange element:
  + The Selected Pairwise Cipher Suite field shall be set to the cipher suite selector that indicates the successfully selected pairwise cipher suite (specified in 14.5.2.1 (Instance Pairwise Cipher Suite selection)).
  + The Peer Nonce field shall be set to the nonce value chosen by the peer mesh STA as received in the Local Nonce field in the Mesh Peering Open frame from the candidate peer mesh STA.
  + The GTKdata field shall not be present.
  + The IGTKdata field shall not be present.
  + The rest of fields are set to the same values sent in the Mesh Peering Open frame.

The Mesh Peering Confirm frame shall be protected using AES-SIV as specified in 14.5.3 (Construction and processing AES-SIV-protected mesh peering Management frames). **References:**