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Use of SHA-256 Algorithm with RSA, DSA and ECDSA in SSHFP Resource Records

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Abstract

This document updates IANA registries defined in RFC4255, which defines a DNS resource record - SSHFP that contains a standard SSH key fingerprint used to verify Secure Shell (SSH) host keys using Domain Name System Security (DNSSEC). This document defines additional options supporting Secure Shell (SSH) public keys using the Elliptic Curve Digital Signature Algorithm (ECDSA) and the use of fingerprints computed using the SHA-256 message digest algorithm in SSHFP resource records (SSHFP RR).

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

The Domain Name System (DNS) is the global, hierarchical distributed database for Internet Naming. The Secure Shell (SSH) is a protocol for secure remote login and other secure network services over an insecure network. RFC 4253 [RFC4253] defines Public Key Algorithms for the Secure Shell server public keys.

The DNS has been extended to store fingerprints in a DNS resource record named SSHFP [RFC4255], which provides out-of-band verification by looking up a fingerprint of the server public key in the DNS [RFC1034], [RFC1035] and using Domain Name System Security Extensions (DNSSEC) [RFC4033], [RFC4034], [RFC4035] to verify the lookup.

RFC 4255 [RFC4255] describes how to store the cryptographic fingerprint of SSH public keys in SSHFP resource records. SSHFP records contain the fingerprint and two index numbers identifying the cryptographic algorithms used:

1. to link the fingerprinted public key with the corresponding private key, and
2. to derive the message digest stored as the fingerprint in the record.

RFC 4255 [RFC4255] then specifies lists of cryptographic algorithms and the corresponding index numbers used to identify them in SSHFP records.

This document updates the IANA registry "SSHFP RR Types for public key algorithms" and "SSHFP RR types for fingerprint types" [SSHFPVALS] by adding a new option in each list:

- the Elliptic Curve Digital Signature Algorithm (ECDSA)[RFC6090] which has been added to the Secure Shell Public Key list by RFC 5656 [RFC5656] in the public key algorithms list;
- the SHA-256 algorithm [FIPS.180-3.2008] in the SSHFP Fingerprint Type list.

Familiarity with DNSSEC, SSH Protocol [RFC4251], [RFC4253],

[RFC4250], SSHFP [RFC4255], and the SHA-2 [FIPS.180-3.2008] family of algorithms is assumed in this document.

2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

3. SSHFP Resource Records

The format of the SSHFP RR can be found in RFC 4255 [RFC4255].

3.1. SSHFP Fingerprint Type Specification

The fingerprint type octet identifies the message-digest algorithm used to calculate the fingerprint of the public key.

3.1.1. SHA-256 SSHFP Fingerprint Type Specification

SHA-256 fingerprints of the public keys are stored in SSHFP Resource Record with the fingerprint type 2.

3.2. SSHFP Algorithm Number Specification

The SSHFP Resource Record algorithm number octet describes the algorithm of the public key.

3.2.1. ECDSA SSHFP Algorithm Number Specification

ECDSA public keys are stored in SSHFP Resource Records with the algorithm number 3.

4. Implementation Considerations

4.1. Support for SHA-256 fingerprints

SSHFP-aware Secure Shell implementations SHOULD support the SHA-256

fingerprints for verification of the public key. Secure Shell implementations which support SHA-256 fingerprints MUST prefer a SHA-256 fingerprint over SHA-1 if both are available for a server. If the SHA-256 fingerprint is tested and does not match the key SSH public key received from the SSH server, then the key MUST be rejected rather than testing the alternative SHA-1 fingerprint.

4.2. Support for ECDSA

SSHFP-aware Secure Shell implementations which also implement ECDSA algorithm for the public key SHOULD support SSHFP fingerprints for ECDSA public keys.

5. Examples

The following examples provide reference for both the newly defined ECDSA algorithm number and the use of the SHA-256 fingerprint combined with both the new and the existing algorithm numbers.

5.1. RSA public key

Given a public key with the following value in OpenSSH format [RFC4716]:

```
---- BEGIN SSH2 PUBLIC KEY ----
AAAAB3NzaC1yc2EAAAADAQABAAABAQDCUR4JOhxTinzq7QO3bQXW4jmPCCulFsnh
8Yi7MKwpMnd96+T7uV7nEwy+6+GWYu98IxFJByIjFXX/a6BXDp3878wezH1DZ2tN
D/tu/eudz6ErpTFYmnVLyEDARYSzVBNQuIK1UDqvvB6KffJcyt78FpwW27euGkqE
kam7GaurPRAgwXehDB/gMwRtXVRZ+13zYWkAmAY+5OAWVmdXuQVm5kjlvcNzto2H
3m3nqJtD4J9L1lKPuSVVqwJr4/6hibXJkQEvWpUvdOAUw3frKpNwa932fXFk3ke4
rsDjQ/W8GyleMtK3Tx8tE4z1wuowXtYe6Ba8q3LAPs/m2S4pUscx
---- END SSH2 PUBLIC KEY ----
```

5.1.1. RSA public key with SHA1 fingerprint

The SSHFP Resource Record for this key would be:

```
server.example.net IN SSHFP 1 1 ( dd465c09cfa51fb45020cc83316fff
                                  21b9ec74ac )
```

5.1.2. RSA public key with SHA-256 fingerprint

The SSHFP Resource Record for this key would be:

```
server.example.net IN SSHFP 1 2 ( b049f950d1397b8fee6a61e4d14a9a
                                  cdc4721e084eff5460bbed80cfaa2c
                                  e2cb )
```

5.2. DSA public key

Given a public key with the following value in OpenSSH format:

```
---- BEGIN SSH2 PUBLIC KEY ----
AAAAB3NzaC1kc3MAAACBAPVFrc0U36gWaywbfJzjcv8ef13qAX4EJl8Na6xqvXh1
t+aCJEdS7soRjtvK4KsNhk78DjdtnfhEhyFKHHNz3i6/c/s9lP0UjV7mRAo6nA7A
3Gs6iQElb6O9Fqm6iVSC6bYWilTSB0tYencEEJUoaAua8YQF/uxRzPrReXxGqHnj
AAAAFQDC9M/pli8VIVmEGOO0wC1TeUTN4wAAAIEAgA2Fbkbbeo0+u/qw8mQFOFWZ
pTaqNo7d7jov3majbh5LqEVD7yT3MS1GSGhjgvvhus/ehMTqzYbjTc0szUM9JnwT
7xq15P2ZYDK98IVxrw31jMtsUUEmBqB4DUjTurtcaWmJ9LNaP1/k4bMo0/hotnOc
OVnIPsTLBFWVvdNRxUAAAACAOZcDcK01NTM1qIIYbBqCffrwjQ+9PmsuSKI6nUzf
S4NysXHkdbW5u5VxeXLcwWj5PGbRfoS2P3vwYAmakqgq502wigam18u9nAczUYl+
2kOeOiIRrtSmLfpV7thLOAb8k1ESjIlkbn35jKmTcoMFRXbFmkKRTK8OEnWQ8AVg
6w8=
---- END SSH2 PUBLIC KEY ----
```


5.2.1. DSA public key with SHA1 fingerprint

The SSHFP Resource Record for this key would be:

```
server.example.net IN SSHFP 2 1 ( 3b6ba6110f5ffcd29469fc1ec2ee25
                                  d61718badd )
```

5.2.2. DSA public key with SHA-256 fingerprint

The SSHFP Resource Record for this key would be:

```
server.example.net IN SSHFP 2 2 ( f9b8a6a460639306f1b38910456a6a
                                  e1018a253c47ecec12db77d7a0878b
                                  4d83 )
```

5.3. ECDSA public key

Given a public key with the following value in OpenSSH format:

```
---- BEGIN SSH2 PUBLIC KEY ----
AAAAE2VjZHNhLXNoYTItbmlzdHAyNTYAAAAIbmlzdHAyNTYAAABBBAD+9COUiX7W
YgcvIOdI8+djdoFDVUTxNrcog8sSYdbIzeG+bYdsssvcyy/nRfVhXC5QBCk8IThq
s7D4/lFxX5g=
---- END SSH2 PUBLIC KEY ----
```

5.3.1. ECDSA public key with SHA1 fingerprint

The SSHFP Resource Record for this key would be:

```
server.example.net IN SSHFP 3 1 ( c64607a28c5300fec1180b6e417b92
                                  2943cffcdd )
```

5.3.2. ECDSA public key with SHA-256 fingerprint

The SSHFP Resource Record for this key would be:

```
server.example.net IN SSHFP 3 2 ( 821eb6c1c98d9cc827ab7f456304c0
                                  f14785b7008d9e8646a8519de80849
                                  afc7 )
```

6. IANA Considerations

This document updates the IANA registry "SSHFP RR Types for public key algorithms" and "SSHFP RR types for fingerprint types" [SSHFPVALS].

6.1. SSHFP RR Types for public key algorithms

The following entries are added to the "SSHFP RR Types for public key algorithms" registry:

Value	Description	Reference

3	ECDSA	[This doc]

Table 1

6.2. SSHFP RR types for fingerprint types

The following entries are added to the "SSHFP RR types for fingerprint types" registry:

Value	Description	Reference
2	SHA-256	[This doc]

Table 2

7. Security Considerations

Please see the security considerations in [RFC4255] for SSHFP record and [RFC5656] for ECDSA algorithm.

Users of SSHFP are encouraged to deploy SHA-256 as soon as implementations allow for it. SHA-2 family of algorithms is widely believed to be more resilient to attack than SHA-1, and confidence in SHA-1's strength is being eroded by recently announced attacks [IACR 2007/474]. Regardless of whether or not the attacks on SHA-1 will affect SSHFP, it is believed (at the time of this writing) that SHA-256 is the better choice for use in SSHFP records.

SHA-256 is considered sufficiently strong for the immediate future, but predictions about future development in cryptography and cryptanalysis are beyond the scope of this document.

8. References

8.1. Normative References

[FIPS.180-3.2008]
National Institute of Standards and Technology, "Secure Hash Standard", FIPS PUB 180-3, October 2008, <http://csrc.nist.gov/publications/fips/fips180-3/fips180-3_final.pdf>.

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[RFC4250] Lehtinen, S. and C. Lonvick, "The Secure Shell (SSH) Protocol Assigned Numbers", RFC 4250, January 2006.

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[RFC4255] Schlyter, J. and W. Griffin, "Using DNS to Securely Publish Secure Shell (SSH) Key Fingerprints", RFC 4255, January 2006.

[RFC5656] Stebila, D. and J. Green, "Elliptic Curve Algorithm Integration in the Secure Shell Transport Layer", RFC 5656, December 2009.

8.2. Informative References

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Cochran, M., "Notes on the Wang et al. 2^63 SHA-1 Differential Path", IACR 2007/474, <http://eprint.iacr.org/2007/474.pdf>.

[RFC4033] Arends, R., Austein, R., Larson, M., Massey, D., and S. Rose, "DNS Security Introduction and Requirements", RFC 4033, March 2005.

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[RFC4035] Arends, R., Austein, R., Larson, M., Massey, D., and S. Rose, "Protocol Modifications for the DNS Security Extensions", RFC 4035, March 2005.

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[RFC6090] McGrew, D., Igoe, K., and M. Salter, "Fundamental Elliptic Curve Cryptography Algorithms", RFC 6090, February 2011.

[SSHFPVALS] IANA, "DNS SSHFP Resource Records Parameters", IANA registry available at:, <http://www.iana.org/assignments/dns-sshfp-rr-parameters/dns-sshfp-rr-parameters.xml>.

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