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More Modular Exponential (MODP) Diffie-Hellman (DH) Key Exchange (KEX)  
Groups for Secure Shell (SSH)  
draft-ietf-curdle-ssh-modp-dh-sha2-02

## Abstract

This document defines added Modular Exponential (MODP) Groups for the Secure Shell (SSH) protocol using SHA-2 hashes.

## Status of This Memo

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More MODP DH KEX Groups for SSH

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## 1. Overview and Rationale

Secure Shell (SSH) is a common protocol for secure communication on the Internet. Due to recent security concerns with SHA-1 [[RFC6194](#)] and with MODP groups with less than 2048 bits [[NIST-SP-800-131Ar1](#)] implementer and users request support for larger Diffie Hellman (DH) MODP group sizes with data integrity verification using the SHA-2 family of secure hash algorithms as well as MODP groups providing more security.

The United States Information Assurance Directorate at the National Security Agency has published a FAQ [[MFQ-U-00-815099-15](#)] suggesting both: a) DH groups using less than 3072-bits, and b) the use of SHA-2 based hashes less than SHA2-384, are no longer sufficient for transport of Top Secret information. For this reason, the new MODP groups are being introduced starting with the MODP 3072-bit group 15 are all using SHA2-512 as the hash algorithm.

The DH 2048-bit MODP group 14 is already present in most SSH implementations and most implementations already have a SHA2-256 implementation, so diffie-hellman-group14-sha256 is provided as an easy to implement and faster to use key exchange for small embedded applications.

Please send comments on this draft to [ietf-ssh@NetBSD.org](mailto:ietf-ssh@NetBSD.org) and [ietf-curdle@ietf.org](mailto:ietf-curdle@ietf.org).

## 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 [[RFC2119](#)].

## 3. Key Exchange Algorithms

This memo adopts the style and conventions of [[RFC4253](#)] in specifying how the use of new data key exchange is indicated in SSH.

The following new key exchange algorithms are defined:

Key Exchange Method Name

diffie-hellman-group14-sha256

diffie-hellman-group15-sha512

```
diffie-hellman-group16-sha512
diffie-hellman-group17-sha512
diffie-hellman-group18-sha512
```

Figure 1

The SHA-2 family of secure hash algorithms are defined in [\[FIPS-180-4\]](#).

The method of key exchange used for the name "diffie-hellman-group14-sha256" is the same as that for "diffie-hellman-group14-sha1" except that the SHA2-256 hash algorithm is used.

The method of key exchange used for the name "gss-group14-sha256-\*" is the same as that for "gss-group14-sha1-\*" except that the SHA2-256 hash algorithm is used.

The group15 through group18 names are the same as those specified in [\[RFC3526\]](#) 3071-bit MODP Group 15, 4096-bit MODP Group 16, 6144-bit MODP Group 17, and 8192-bit MODP Group 18.

The SHA2-512 algorithm is to be used when "sha512" is specified as a part of the key exchange method name.

#### [4.](#) IANA Considerations

This document augments the Key Exchange Method Names in [\[RFC4253\]](#).

IANA is requested to add to the Key Exchange Method Names algorithm registry with the following entries:

Key Exchange Method Name	Reference
-----	-----
diffie-hellman-group14-sha256	This Draft
diffie-hellman-group15-sha512	This Draft
diffie-hellman-group16-sha512	This Draft
diffie-hellman-group17-sha512	This Draft
diffie-hellman-group18-sha512	This Draft

[TO BE REMOVED: This registration should take place at the following location: <<http://www.iana.org/assignments/ssh-parameters/ssh-parameters.xhtml#ssh-parameters-16>>]

## 5. Security Considerations

The security considerations of [RFC4253] apply to this document.

The security considerations of [RFC3526] suggest that these MODP groups have security strengths given in this table. They are based on [RFC3766] Determining Strengths For Public Keys Used For Exchanging Symmetric Keys.

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Group modulus security strength estimates (RFC3526)

Group	Modulus	Strength Estimate 1		Strength Estimate 2	
		in bits		in bits	
		exponent size	exponent size	exponent size	exponent size
14	2048-bit	110	220-	160	320-
15	3072-bit	130	260-	210	420-
16	4096-bit	150	300-	240	480-
17	6144-bit	170	340-	270	540-
18	8192-bit	190	380-	310	620-

Figure 2

Many users seem to be interested in the perceived safety of using larger MODP groups and hashing with SHA2-based algorithms.

## 6. References

### 6.1. Normative References

[FIPS-180-4]

National Institute of Standards and Technology, "Secure Hash Standard (SHS)", FIPS PUB 180-4, August 2015, <<http://nvlpubs.nist.gov/nistpubs/FIPS/NIST.FIPS.180-4.pdf>>.

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), DOI 10.17487/RFC2119, March 1997, <<http://www.rfc-editor.org/info/rfc2119>>.
- [RFC3526] Kivinen, T. and M. Kojo, "More Modular Exponential (MODP) Diffie-Hellman groups for Internet Key Exchange (IKE)", [RFC 3526](#), DOI 10.17487/RFC3526, May 2003, <<http://www.rfc-editor.org/info/rfc3526>>.
- [RFC4253] Ylonen, T. and C. Lonvick, Ed., "The Secure Shell (SSH) Transport Layer Protocol", [RFC 4253](#), DOI 10.17487/RFC4253, January 2006, <<http://www.rfc-editor.org/info/rfc4253>>.

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## [6.2](#). Informative References

- [MFQ-U-00-815099-15]  
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- [NIST-SP-800-131Ar1]  
Barker, and Roginsky, "Transitions: Recommendation for the Transitioning of the Use of Cryptographic Algorithms and Key Lengths", NIST Special Publication 800-131A Revision 1, November 2015, <<http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-131Ar1.pdf>>.
- [RFC3766] Orman, H. and P. Hoffman, "Determining Strengths For Public Keys Used For Exchanging Symmetric Keys", [BCP 86](#), [RFC 3766](#), DOI 10.17487/RFC3766, April 2004, <<http://www.rfc-editor.org/info/rfc3766>>.

[RFC6194] Polk, T., Chen, L., Turner, S., and P. Hoffman, "Security Considerations for the SHA-0 and SHA-1 Message-Digest Algorithms", [RFC 6194](#), DOI 10.17487/RFC6194, March 2011, <<http://www.rfc-editor.org/info/rfc6194>>.

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