Network Working Group
Internet Draft
<draft-ietf-dkim-ssp-04>
Intended status: Standards Track
Expires: January 2009

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July 9, 2008

DKIM Author Domain Signing Practices (ADSP)

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Status of this Memo

Abstract

DomainKeys Identified Mail (DKIM) defines a domain-level authentication framework for email to permit verification of the source and contents of messages. This document specifies an adjunct mechanism to aid in assessing messages that do not contain a DKIM signature for the domain used in the author's address. It defines a record that can advertise whether they sign their outgoing mail, and how other hosts can access those records.

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1. Introduction

DomainKeys Identified Mail (DKIM) defines a mechanism by which email messages can be cryptographically signed, permitting a signing domain to claim responsibility for the introduction of a message into the mail stream. Message recipients can verify the signature by querying the signer's domain directly to retrieve the appropriate public key, and thereby confirm that the message was attested to by a party in possession of the private key for the signing domain.

However, the legacy of the Internet is such that not all messages will be signed, and the absence of a signature on a message is not an a priori indication of forgery. In fact, during early phases of deployment it is very likely that most messages will remain unsigned. However, some domains might decide to sign all of their outgoing mail, for example, to protect their brand names. It is desirable for such domains to be able to advertise that fact to other hosts. This is the topic of Author Domain Signing Practices (ADSP).

Hosts implementing this specification can inquire what Author Signing Practices a domain advertises. This inquiry is called an Author Signing Practices check.

The basic requirements for ADSP are given in [RFC5016]. This document refers extensively to [RFC4871] and assumes the reader is familiar with it.

Requirements Notation: 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]

2. Language and Terminology

2.1 Terms Imported from DKIM Signatures Specification

Some terminology used herein is derived directly from [RFC4871]. In several cases, references in that document to Sender have been changed to Author here, to emphasize the relationship to the Author address(es) in the From: header field described in [RFC2822]. Briefly,

- A "Signer" is the agent that signs a message, as defined in section 2.1 of [RFC4871].
- A "Local-part" is the part of an address preceding the @ character, as defined in [RFC2822] and used in [RFC4871].

2.2 Valid Signature

A "Valid Signature" is any signature on a message which correctly verifies using the procedure described in section 6.1 of [RFC4871].

2.3 Author Address

An "Author Address" is an email address in the From header field of a message [RFC2822]. If the From header field contains multiple addresses, the message has multiple Author Addresses.

2.4 Author Domain

An "Author Domain" is everything to the right of the "@" in an Author Address (excluding the "@" itself).

2.5 Alleged Author

An "Alleged Author" is an Author Address of a message; it is "alleged" because it has not yet been verified.

2.6 Author Domain Signing Practices

"Author Domain Signing Practices" (or just "practices") consist of a machine-readable record published by the domain of an Alleged Author which includes statements about the domain's practices with respect to mail it sends with its domain in the From: line.

2.7 Author Signature

An "Author Signature" is any Valid Signature where the identity of the user or agent on behalf of which the message is signed (listed in the `i=` tag or its default value from the `d=` tag) matches an Author Address in the message. When the identity of the user or agent includes a Local-part, the identities match if the Local-parts are the same string, and the domains are the same string. Otherwise, the identities match if the domains are the same string. Following [RFC2821], Local-part comparisons are case sensitive, domain comparisons are case insensitive.

For example, if a message has a Valid Signature, with the DKIM-Signature field containing `i=a@domain.example`, then domain.example is asserting that it takes responsibility for the message. If the message's From: field contains the address `b@domain.example` and an ADSP query produces a `dkim=all` or `dkim=discardable` result, that would mean that the message does not have a valid Author Signature. Even though the message is signed by the same domain, it fails to satisfy ADSP.

3. Operation Overview

Domain owners can publish ADSP information via a query mechanism such as the Domain Name System; specific details are given in Section 4.1.

Hosts can look up the ADSP information of the domain(s) specified by the Author Address(es) as described in Section 4.3. If a message has multiple Author Addresses the ADSP lookups SHOULD be performed independently on each address. This standard does not address the process a host might use to combine the lookup results.

3.1 ADSP Applicability

ADSP as defined in this document is bound to DNS. For this reason, ADSP is applicable only to Author Domains with appropriate DNS records (see Note below). The handling of other Author Domains is outside the scope of this document. However, attackers may use such domain names in a deliberate attempt to sidestep an organization's ADSP policy statements. It is up to the ADSP verifier implementation to return an appropriate error result for Author Domains outside the scope of ADSP.

Note: The results from DNS queries that are intended to validate a domain name unavoidably approximate the set of Author Domains that can appear in legitimate email. For example, a DNS A record could belong to a device that does not even have an email implementation. It is up to the verifier to decide what degree of approximation is acceptable.

3.2 ADSP Usage

Depending on the Author Domain(s) and the signatures in a message, a recipient gets varying amounts of useful information from each ADSP lookup.

- If a message has no Valid Signature, the ADSP result is directly relevant to the message.
- If a message has a Valid Signature from an Author Domain, ADSP provides no benefit relative to that domain since the message is already known to be compliant with any possible ADSP for that domain.
- If a message has a Valid Signature from a domain other than an Author Domain, the receiver can use both the Signature and the ADSP result in its evaluation of the message.

3.3 ADSP Results

An ADSP lookup for an Author Address produces one of four possible results:

- Messages from this domain might or might not have an author signature. This is the default if the domain exists in the DNS but no record is found.
- All messages from this domain are signed.
- All messages from this domain are signed and discardable.
- The domain is not a valid mail domain.

4. Detailed Description

4.1 DNS Representation

ADSP records are published using the DNS TXT resource record type.

The RDATA for ADSP resource records is textual in format, with specific syntax and semantics relating to their role in describing ADSP. The "Tag=Value List" syntax described in section 3.2 of [RFC4871] is used. Records not in compliance with that syntax or the syntax of individual tags described in Section 4.3 MUST be ignored (considered equivalent to a NODATA result) for purposes of ADSP, although they MAY cause the logging of warning messages via an appropriate system logging mechanism. If the RDATA contains multiple character strings, the strings are logically concatenated with no delimiters between the strings.

The ADSP record for a domain is published at a location in the domain's DNS hierarchy prefixed by _adsp._domainkey.; e.g., the ADSP record for example.com would be a TXT record that is published at `_adsp._domainkey.example.com`. A domain MUST NOT publish more than one ADSP record; the semantics of an ADSP lookup that returns multiple ADSP records for a single domain are undefined. (Note that example.com and mail.example.com are different domains.)

4.2 Publication of ADSP Records

ADSP is intended to apply to all mail sent using the domain name string of an Alleged Author.

Wildcards within a domain publishing ADSP records pose a particular problem. This is discussed in more detail in Section 6.3.

4.2.1 Record Syntax

ADSP records use the "tag=value" syntax described in section 3.2 of [RFC4871].

Tags used in ADSP records are described below. Unrecognized tags MUST be ignored. In the ABNF below, the FWS token is imported from [RFC4871]. The ALPHA and DIGIT tokens are imported from [RFC5234].

dkim= Outbound signing practices for the domain (plain-text; REQUIRED). Possible values are as follows:

- unknown — The domain might sign some or all email.
- all — All mail from the domain is signed with an Author Signature.
- discardable — All mail from the domain is signed with an Author Signature. Furthermore, if a message arrives without a valid Author Signature due to modification in transit, submission via a path without access to a signing key, or other reason, the domain encourages the recipient(s) to discard it.

ABNF:

```
adsp-dkim-tag = %x64.6b.69.6d *FWS "=" *FWS
                ("unknown" / "all" / "discardable")
```

4.3 ADSP Lookup Procedure

Hosts doing an ADSP lookup MUST produce a result that is semantically equivalent to applying the following steps in the order listed below. In practice, these steps can be performed in parallel in order to improve performance. However, implementations SHOULD avoid doing unnecessary DNS lookups.

For the purposes of this section a "valid ADSP record" is one that is both syntactically and semantically correct; in particular, it matches the ABNF for a `tag-list` and includes a defined `dkim=` tag.

Verify Domain Scope:

An ADSP verifier implementation MUST determine whether a given Author Domain is within scope for ADSP. Given the background in Section 3.1 the verifier MUST decide which degree of over-approximation is acceptable. The verifier MUST return an appropriate error result for Author Domains that are outside the scope of ADSP.

The host MUST perform a DNS query for a record corresponding to the Author Domain (with no prefix). The type of the query can be of any type, since this step is only to determine if the domain itself exists in DNS. This query MAY be done in parallel with the query to fetch the Named ADSP Record. If the result of this query is that the Author domain does not exist in the DNS (often called an `NXDOMAIN` error), the algorithm MUST terminate with an error indicating that the domain is out of scope.

> NON-NORMATIVE DISCUSSION: Any resource record type could be used for this query since the existence of a resource record of any type will prevent an `NXDOMAIN` error. MX is a reasonable choice for this purpose because this record type is thought to be the most common for domains used in e-mail, and will therefore produce a result which can be more readily cached than a negative result.

If the domain does exist, the verifier MAY make more extensive checks to verify the existence of the domain, such as the ones described in Section 5 of [RFC2821]. If those checks indicate that the Author domain does not exist for mail, e.g., the domain has no MX, A, or AAAA record, the verifier SHOULD terminate with an error indicating that the domain is out of scope.

Fetch Named ADSP Record:

The host MUST query DNS for a TXT record corresponding to the Author Domain prefixed by `_adsp._domainkey.` (note the trailing dot).

If the result of this query is a `NOERROR` response with an answer which is a valid ADSP record, use that record, and the algorithm terminates.

If a query results in a `SERVFAIL` error response, the algorithm terminates without returning a result; possible actions include queuing the message or returning an SMTP error indicating a temporary failure.

5. IANA Considerations

ADSP adds the following namespaces to the IANA registry. In all cases, new values are assigned only for values that have been documented in a published RFC that has IETF Consensus [RFC2434].

5.1 ADSP Specification Tag Registry

An ADSP record provides for a list of specification tags. IANA has established the ADSP Specification Tag Registry for specification tags that can be used in ADSP fields.

The initial entry in the registry is:

```
+------+-----------------+
| TYPE | REFERENCE       |
+------+-----------------+
| dkim | (this document) |
+------+-----------------+
```

ADSP Specification Tag Registry Initial Values

5.2 ADSP Outbound Signing Practices Registry

The `dkim=` tag spec, defined in Section 4.2.1, provides for a value specifying Outbound Signing Practices. IANA has established the ADSP Outbound Signing Practices Registry for Outbound Signing Practices.

The initial entries in the registry comprise:

```
+-------------+-----------------+
| TYPE        | REFERENCE       |
+-------------+-----------------+
| unknown     | (this document) |
| all         | (this document) |
| discardable | (this document) |
+-------------+-----------------+
```

ADSP Outbound Signing Practices Registry Initial Values

6. Security Considerations

Security considerations in the ADSP are mostly related to attempts on the part of malicious senders to represent themselves as authors for whom they are not authorized to send mail, often in an attempt to defraud either the recipient or an Alleged Author.

Additional security considerations regarding Author Domain Signing Practices are found in the DKIM threat analysis [RFC4686].

6.1 ADSP Threat Model

Email recipients often have a core set of content authors that they already trust. Common examples include financial institutions with which they have an existing relationship and Internet web transaction sites with which they conduct business.

Email abuse often seeks to exploit a legitimate email author's name-recognition among recipients, by using the author's domain name in the From: header field. Especially since many popular MUAs do not display the author's email address, there is no empirical evidence of the extent that this particular unauthorized use of a domain name contributes to recipient deception or that eliminating it will have significant effect.

However, closing this exploit could facilitate some types of optimized processing by receive-side message filtering engines, since it could permit them to maintain higher-confidence assertions about From: header field uses of a domain, when the occurrence is authorized.

Unauthorized uses of domain names occur elsewhere in messages, as do unauthorized uses of organizations' names. These attacks are outside the scope of this specification.

ADSP does not provide any benefit--nor, indeed, have any effect at all--unless an external system acts upon the verdict, either by treating the message differently during the delivery process or by showing some indicator to the end recipient. Such a system is out of scope for this specification.

ADSP checkers may perform multiple DNS lookups per Alleged Author Domain. Since these lookups are driven by domain names in email message headers of possibly fraudulent email, legitimate ADSP checkers can become participants in traffic multiplication attacks.

6.2 DNS Attacks

An attacker might attack the DNS infrastructure in an attempt to impersonate ADSP records to influence a receiver's decision on how it will handle mail. However, such an attacker is more likely to attack at a higher level, e.g., redirecting A or MX record lookups in order to capture traffic that was legitimately intended for the target domain. These DNS security issues are addressed by DNSSEC [RFC4033].

Because ADSP operates within the framework of the legacy e-mail system, the default result in the absence of an ADSP record is that the domain does not sign all of its messages. It is therefore important that the ADSP clients distinguish a DNS failure such as `SERVFAIL` from other DNS errors so that appropriate actions can be taken.

6.3 DNS Wildcards

If a domain contains wildcards, then any name that matches the wildcard according to [RFC4592] is potentially a valid mail domain eligible for ADSP. It is possible to add a wildcard TXT record

alongside a wildcard MX that will provide suitable ADSP records for any domain chosen by an attacker, since if the wildcard synthesizes chosen-name.example.com IN MX, it will then also synthesize _adsp._domainkey.chosen-name.example.com IN TXT. However multiple wildcard TXT records produce an undefined ADSP result, which means you cannot also publish both ADSP records and records for any other TXT-using protocol (such as SPF) for a wildcard domain.

7. References

7.1 References - Normative

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC2434] Narten, T. and H.T. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 2434, October 1998.

[RFC2822] Resnick, P., "Internet Message Format", RFC 2822, April 2001.

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

[RFC4686] Fenton, J., "Analysis of Threats Motivating DomainKeys Identified Mail (DKIM)", RFC 4686, September 2006.

[RFC4871] Allman, E., Callas, J., Delany, M., Libbey, M., Fenton, J., and M. Thomas, "DomainKeys Identified Mail (DKIM) Signatures", RFC 4871, May 2007.

[RFC5234] Crocker, D. and P. Overell, "Augmented BNF for Syntax Specifications: ABNF", STD 68, RFC 5234, January 2008.

7.2 References - Informative

[RFC2821] Klensin, J., "Simple Mail Transfer Protocol", RFC 2821, April 2001.

[RFC5016] Thomas, M., "Requirements for a DomainKeys Identified Mail (DKIM) Signing Practices Protocol", RFC 5016, October 2007.

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A. Usage Examples

These examples are intended to illustrate typical uses of ADSP. They are not intended to be exhaustive, nor to apply to every domain's or mail system's individual situation.

Domain managers are advised to consider the ways that mail processing can modify messages in ways that will invalidate an existing DKIM signature, such as mailing lists, courtesy forwarders, and other paths that could add or modify headers, or modify the message body. In that case, if the modifications invalidate the DKIM signature, recipient hosts will consider the mail not to have an Author Signature, even though the signature was present when the mail was originally sent.

A.1 Single Location Domains

A common mail system configuration handles all of a domain's users' incoming and outgoing mail through a single MTA or group of MTAs. In that case, the MTA(s) can be configured to sign outgoing mail with an Author Signature.

In this situation it might be appropriate to publish an ADSP record for the domain containing "all", depending on whether the users also send mail through other paths that do not apply an Author Signature. Such paths could include MTAs at hotels or hotspot networks used by travelling users, or web sites that provide "mail an article" features.

A.2 Bulk Mailing Domains

Another common configuration uses a domain solely for bulk or broadcast mail, with no individual human users, again typically sending all the mail through a single MTA or group of MTAs that can apply an Author Signature. In this case, the domain's management can be confident that all of its outgoing mail will be sent through the signing MTA. Lacking individual users, the domain is unlikely to participate in mailing lists, but could still send mail through other paths that might invalidate signatures.

Domain owners often use specialist mailing providers to send their bulk mail. In that case, the mailing provider needs access to a suitable signing key in order to apply an Author Signature. One possible route would be for the domain owner to generate the key and give it to the mailing provider. Another would be for the domain to delegate a subdomain to the mailing provider, for example, bigbank.example might delegate email.bigbank.example to such a provider. In that case, the provider can generate the keys and DKIM DNS records itself and use the subdomain in the Author address in the mail.

Regardless of the DNS and key management strategy chosen, whoever maintains the DKIM records for the domain could also install an ADSP record containing "all".

A.3 Bulk Mailing Domains with Discardable Mail

In some cases, a domain might sign all of its outgoing mail with an Author Signature, but prefer that recipient systems discard mail without a valid Author Signature to avoid confusion from mail sent from sources that do not apply an Author Signature. (This latter kind of mail is sometimes loosely called "forgeries".) In that case, it might be appropriate to publish an ADSP record containing "discardable". Note that a domain SHOULD NOT publish a "discardable" record if it wishes to maximize the likelihood that mail from the domain is delivered, since it could cause some fraction of the mail the domain sends to be discarded.

A.4 Third Party Senders

Another common use case is for a third party to enter into an agreement whereby that third party will send bulk or other mail on behalf of a designated author or author domain, using that domain in the RFC2822 From: or other headers. Due to the many and varied complexities of such agreements, third party signing is not addressed in this specification.

A.5 Non-email Domains

If a domain sends no mail at all, it can safely publish a "discardable" ADSP record, since any mail with an author address in the domain is a forgery.

B. Acknowledgements

This document greatly benefited from comments by Steve Atkins, Jon Callas, Dave Crocker, JD Falk, Arvel Hathcock, Ellen Siegel, Michael Thomas, and Wietse Venema.

C. Change Log

NOTE TO RFC EDITOR: This section may be removed upon publication of this document as an RFC.

C.1 Changes since -ietf-dkim-03

- Name change for title and filename, to be ADSP
- String changes throughout, to author Domain signing practices and to aDsp.
- Added some keywords.
- Clarified comparison of local part and domain in Author Address.
- Streamlined the Abstract.
- Revised text of last bullet in Results list.
- Removed definitions not used in the document.
- Removed all specification details pertaining to sub-domains.
- Moved Lookup Procedure up one document level.
- Revised domain validity specification. Part in ADSP Usage in Operations section, and part as it as first step in Lookup.
- Fixed xml for figures, including labeling ABNF with new xml2rfc construct.
- Revised wildcard text.
- Removed 't' tag.
- Removed ADSP Flags Registry section.
- Changed ABNF use of whitespace from WSP back to FWS, for consistency with dkim-base.

C.2 Changes since -ietf-dkim-02

- Merge in more text from ADSP draft.
- Phrase actions as host's rather than checker.
- Explanatory description of i= matching.
- Lookup procedure consistently refers to one ADSP record per lookup.
- Update security section w/ language from W. Venema
- Simplify imports of terms from other RFCs, add Local-part, 4234 -> 5234.
- Add usage example appendix.
- Add IANA considerations.
- Update authors list

C.3 Changes since -ietf-dkim-ssp-01

- Reworded introduction for clarity.
- Various definition clarifications.
- Changed names of practices to unknown, all, and discardable.
- Removed normative language mandating use of SSP in particular situations (issue 1538).

- Clarified possible confusion over handling of syntax errors.
- Removed normative language from Introduction (issue 1538).
- Changed "Originator" to "Author" throughout (issue 1529).
- Removed all references to Third-Party Signatures (issues 1512, 1521).
- Removed all mention of "Suspicious" (issues 1528, 1530).
- Removed "t=y" (testing) flag (issue 1540).
- Removed "handling" tag (issue 1513).
- Broke up the "Sender Signing Practices Check Procedure" into two algorithms: fetching the SSP record and interpretation thereof (issues 1531, 1535; partially addresses issue 1520). Interpretation is now the responsibility of the Evaluator.
- Document restructuring for better flow and remove redundancies (some may address issue 1523, but I'm not sure I understand that issue completely; also issues 1532, 1537).
- Removed all mention of how this interacts with users, even though it makes parts of the document harder to understand (issue 1526).
- Introduced the concepts of "SSP Checker" and "Evaluator".
- Multiple author case now handled my separate invocations of SSP checker by Evaluator (issue 1525).
- Removed check to avoid querying top-level domains.
- Changed ABNF use of whitespace from [FWS] to *WSP (partially addresses issue 1543).

C.4 Changes since -ietf-dkim-ssp-00

- Clarified Operation Overview and eliminated use of Legitimate as the counterpart of Suspicious since the words have different meanings.
- Improved discussion (courtesy of Arvel Hathcock) of the use of TXT records in DNS vs. a new RR type.
- Clarified publication rules for multilevel names.
- Better description of overall record syntax, in particular that records with unknown tags are considered syntactically correct.
- Clarified Sender Signing Practices Check Procedure, primarily by use of new term Author Domain.
- Eliminated section "Third-Party Signatures and Mailing Lists" that is better included in the DKIM overview document.
- Added "handling" tag to express alleged sending domain's preference about handling of Suspicious messages.
- Clarified handling of SERVFAIL error in SSP check.
- Replaced "entity" with "domain", since with the removal of user-granularity SSP, the only entities having sender signing policies are domains.

C.5 Changes since -allman-ssp-02

- Removed user-granularity SSP and u= tag.
- Replaced DKIMP resource record with a TXT record.
- Changed name of the primary tag from "p" to "dkim".
- Replaced lookup algorithm with one which traverses upward at most one level.

- Added description of records to be published, and effect of wildcard records within the domain, on SSP.

C.6 Changes since -allman-ssp-01

- Changed term "Sender Signing Policy" to "Sender Signing Practices".
- Changed query methodology to use a separate DNS resource record type, DKIMP.
- Changed tag values from SPF-like symbols to words.
- User level policies now default to that of the domain if not specified.
- Removed the "Compliance" section since we're still not clear on what goes here.
- Changed the "parent domain" policy to only search up one level (assumes that subdomains will publish SSP records if appropriate).
- Added detailed description of SSP check procedure.

C.7 Changes since -allman-ssp-00

From a "diff" perspective, the changes are extensive. Semantically, the changes are:

- Added section on "Third-Party Signatures and Mailing Lists"
- Added "Compliance" (transferred from -base document). I'm not clear on what needs to be done here.
- Extensive restructuring.

Full Copyright Statement

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