                  Service Location Protocol, Version 2

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Abstract

   The Service Location Protocol provides a scalable framework for the
   discovery and selection of network services. Using this protocol,
   computers using the Internet need little or no static configuration
   of network services for network based applications. This is
   especially important as computers become more portable, and users
   less tolerant or able to fulfill the demands of network system
   administration.

Table of Contents

1. Introduction

   The Service Location Protocol (SLP) provides a flexible and scalable
   framework for providing hosts with access to information about the
   existence, location, and configuration of networked services.
   Traditionally, users have had to find services by knowing the name of
   a network host (a human readable text string) which is an alias for a
   network address. SLP eliminates the need for a user to know the name
   of a network host supporting a service. Rather, the user supplies
   the desired type of service and a set of attributes which describe
   the service. Based on that description, the Service Location
   Protocol resolves the network address of the service for the user.

   SLP provides a dynamic configuration mechanism for applications in
   local area networks. Applications are modeled as clients that need
   to find servers attached to any of the available networks within an
   enterprise. For cases where there are many different clients and/or
   services available, the protocol is adapted to make use of nearby
   Directory Agents that offer a centralized repository for advertised
   services.

   This document updates SLPv1 [RFC 2165], correcting protocol errors,
   adding some enhancements and removing some requirements. This
   specification has two parts. The first describes the required
   features of the protocol. The second describes the extended features
   of the protocol which are optional, and allow greater scalability.

1.1. Applicability Statement

   SLP is intended to function within networks under cooperative
   administrative control. Such networks permit a policy to be
   implemented regarding security, multicast routing and organization of
   services and clients into groups which are not be feasible on the
   scale of the Internet as a whole.

   SLP has been designed to serve enterprise networks with shared
   services, and it may not necessarily scale for wide-area service
   discovery throughout the global Internet, or in networks where there
   are hundreds of thousands of clients or tens of thousands of
   services.

2. Terminology

     User Agent (UA)
               A process working on the user's behalf to establish
               contact with some service. The UA retrieves service
               information from the Service Agents or Directory Agents.

     Service Agent (SA) A process working on the behalf of one or more
               services to advertise the services.

     Directory Agent (DA) A process which collects service
               advertisements. There can only be one DA present per
               given host.

     Service Type Each type of service has a unique Service Type
               string.

     Naming Authority The agency or group which catalogues given
               Service Types and Attributes. The default Naming
               Authority is IANA.

     Scope A set of services, typically making up a logical
               administrative group.

     URL A Universal Resource Locator [8].

2.1. Notation Conventions

   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 [9].

     Syntax   Syntax for string based protocols follow the
                   conventions defined for ABNF [11].

     Strings   All strings are encoded using the UTF-8 [23]
                   transformation of the Unicode [6] character set and
                   are NOT null terminated when transmitted. Strings
                   are preceded by a two byte length field.

     <string-list> A comma delimited list of strings with the
                   following syntax:

                        string-list = string / string ',' string-list

   In format diagrams, any field ending with a \ indicates a variable
   length field, given by a prior length field in the protocol.

3. Protocol Overview

   The Service Location Protocol supports a framework by which client
   applications are modeled as 'User Agents' and services are advertised
   by 'Service Agents.' A third entity, called a 'Directory Agent'
   provides scalability to the protocol.

   The User Agent issues a 'Service Request' (SrvRqst) on behalf of the
   client application, specifying the characteristics of the service
   which the client requires. The User Agent will receive a Service
   Reply (SrvRply) specifying the location of all services in the
   network which satisfy the request.

   The Service Location Protocol framework allows the User Agent to
   directly issue requests to Service Agents. In this case the request
   is multicast. Service Agents receiving a request for a service which
   they advertise unicast a reply containing the service's location.

```
    +------------+ ----Multicast SrvRqst----> +--------------+
    | User Agent |                            | Service Agent |
    +------------+ <----Unicast SrvRply------ +--------------+
```
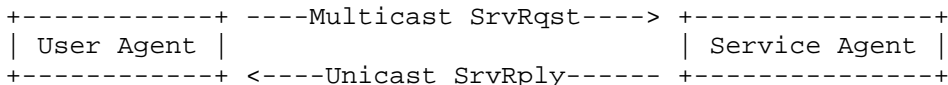
   In larger networks, one or more Directory Agents are used. The
   Directory Agent functions as a cache. Service Agents send register
   messages (SrvReg) containing all the services they advertise to
   Directory Agents and receive acknowledgements in reply (SrvAck).
   These advertisements must be refreshed with the Directory Agent or
   they expire. User Agents unicast requests to Directory Agents
   instead of Service Agents if any Directory Agents are known.

```
 +-------+ -Unicast SrvRqst-> +-----------+ <-Unicast SrvReg- +--------+
 | User  |                    | Directory |                   |Service |
 | Agent |                    |   Agent   |                   | Agent  |
 +-------+ <-Unicast SrvRply- +-----------+ -Unicast SrvAck-> +--------+
```
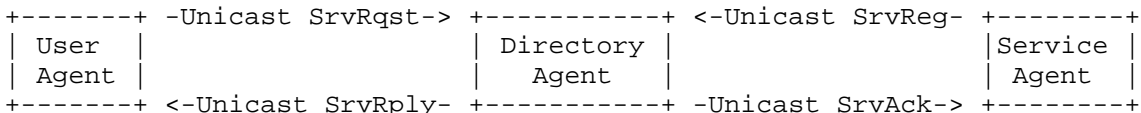
   User and Service Agents discover Directory Agents two ways. First,
   they issue a multicast Service Request for the 'Directory Agent'
   service when they start up. Second, the Directory Agent sends an
   unsolicited advertisement infrequently, which the User and Service
   Agents listen for. In either case the Agents receive a DA
   Advertisement (DAAdvert).

```
    +---------------+ --Multicast SrvRqst-> +-----------+
    |    User or    | <--Unicast DAAdvert-- | Directory |
    | Service Agent |                       |   Agent   |
    +---------------+ <-Multicast DAAdvert- +-----------+
```
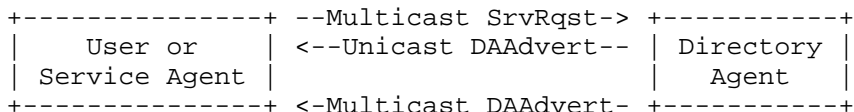
Services are grouped together using 'scopes'. These are strings
which identify services which are administratively identified. A
scope could indicate a location, administrative grouping, proximity
in a network topology or some other category. Service Agents and
Directory Agents are always assigned a scope string.

A User Agent is normally assigned a scope string (in which case the
User Agent will only be able to discover that particular grouping of
services). This allows a network administrator to 'provision'
services to users. Alternatively, the User Agent may be configured
with no scope at all. In that case, it will discover all available
scopes and allow the client application to issue requests for any
service available on the network.

```
+---------+  Multicast  +-----------+  Unicast  +-----------+
| Service | <--SrvRqst-- |   User    | --SrvRqst-> | Directory |
|  Agent  |              |   Agent   |             |   Agent   |
| Scope=X |   Unicast    | Scope=X,Y |   Unicast   |  Scope=Y  |
+---------+ --SrvRply--> +-----------+ <-SrvRply-- +-----------+
```
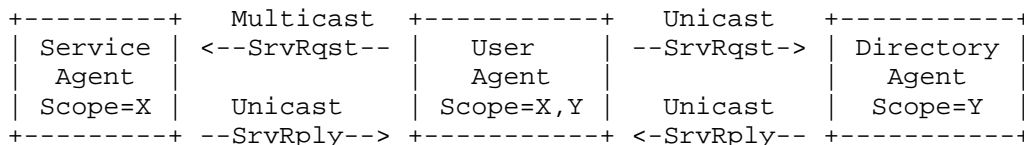
In the above illustration, the User Agent is configured with scopes X
and Y. If a service is sought in scope X, the request is multicast.
If it is sought in scope Y, the request is unicast to the DA.
Finally, if the request is to be made in both scopes, the request
must be both unicast and multicast.

Service Agents and User Agents may verify digital signatures provided
with DAAdverts. User Agents and Directory Agents may verify service
information registered by Service Agents. The keying material to use
to verify digital signatures is identified using a SLP Security
Parameter Index, or SLP SPI.

Every host configured to generate a digital signature includes the
SLP SPI used to verify it in the Authentication Block it transmits.
Every host which can verify a digital signature must be configured
with keying material and other parameters corresponding with the SLP
SPI such that it can perform verifying calculations.

SAs MUST accept multicast service requests and unicast service
requests. SAs MAY accept other requests (Attribute and Service Type
Requests). SAs MUST listen for multicast DA Advertisements.

The features described up to this point are required to implement. A
minimum implementation consists of a User Agent, Service Agent or
both.

There are several optional features in the protocol. Note that DAs
MUST support all these message types, but DA support is itself

optional to deploy on networks using SLP. UAs and SAs MAY support
these message types. These operations are primarily for interactive
use (browsing or selectively updating service registrations.) UAs
and SAs either support them or not depending on the requirements and
constraints of the environment where they will be used.

Service Type Request   A request for all types of service on the
                         network. This allows generic service browsers
                         to be built.

Service Type Reply   A reply to a Service Type Request.

Attribute Request   A request for attributes of a given type of
                         service or attributes of a given service.

Attribute Reply   A reply to an Attribute Request.

Service Deregister   A request to deregister a service or some
                         attributes of a service.

Service Update   A subsequent SrvRqst to an advertisement.
                         This allows individual dynamic attributes to
                         be updated.

SA Advertisement   In the absence of Directory Agents, a User
                         agent may request Service Agents in order
                         to discover their scope configuration. The
                         User Agent may use these scopes in requests.

In the absence of Multicast support, Broadcast MAY be used. The
location of DAs may be statically configured, discovered using SLP as
described above, or configured using DHCP. If a message is too large,
it may be unicast using TCP.

A SLPv2 implementation SHOULD support SLPv1 [22]. This support
includes:

1. SLPv2 DAs are deployed, phasing out SLPv1 DAs.

2. Unscoped SLPv1 requests are considered to be of DEFAULT scope.
   SLPv1 UAs MUST be reconfigured to have a scope if possible.

3. There is no way for an SLPv2 DA to behave as an unscoped SLPv1
   DA. SLPv1 SAs MUST be reconfigured to have a scope if possible.

4. SLPv2 DAs answer SLPv1 requests with SLPv1 replies and SLPv2
   requests with SLPv2 replies.

   5. SLPv2 DAs use registrations from SLPv1 and SLPv2 in the same
      way. That is, incoming requests from agents using either version
      of the protocol will be matched against this common set of
      registered services.

   6. SLPv2 registrations which use Language Tags which are greater
      than 2 characters long will be inaccessible to SLPv1 UAs.

   7. SLPv2 DAs MUST return only service type strings in SrvTypeRply
      messages which conform to SLPv1 service type string syntax, ie.
      they MUST NOT return Service Type strings for abstract service
      types.

   8. SLPv1 SrvRqsts and AttrRqsts by Service Type do not match Service
      URLs with abstract service types. They only match Service URLs
      with concrete service types.

   SLPv1 UAs will not receive replies from SLPv2 SAs and SLPv2 UAs will
   not receive replies from SLPv1 SAs. In order to interoperate UAs and
   SAs of different versions require a SLPv2 DA to be present on the
   network which supports both protocols.

   The use of abstract service types in SLPv2 presents a backward
   compatibility issue for SLPv1. It is possible that a SLPv1 UA will
   request a service type which is actually an abstract service type.
   Based on the rules above, the SLPv1 UA will never receive an abstract
   Service URL reply. For example, the service type 'service:x' in a
   SLPv1 AttrRqst will not return the attributes of 'service:x:y://orb'.
   If the request was made with SLPv2, it would return the attributes of
   this service.

4. URLs used with Service Location

   A Service URL indicates the location of a service. This URL may be
   of the service: scheme [13] (reviewed in section 4.1), or any other
   URL scheme conforming to the URI standard [8], except that URLs
   without address specifications SHOULD NOT be advertised by SLP. The
   service type for an 'generic' URL is its scheme name. For example,
   the service type string for "http://www.srvloc.org" would be "http".

   Reserved characters in URLs follow the rules in RFC 2396 [8].

4.1. Service: URLs

   Service URL syntax and semantics are defined in [13]. Any network
   service may be encoded in a Service URL.

   This section provides an introduction to Service URLs and an example
   showing a simple application of them, representing standard network
   services.

   A Service URL may be of the form:

      "service:"<srvtype>"://"<addrspec>

   The Service Type of this service: URL is defined to be the string up
   to (but not including) the final ':' before <addrspec>, the address
   specification.

   <addrspec> is a hostname (which should be used if possible) or dotted
   decimal notation for a hostname, followed by an optional ':' and
   port number.

   A service: scheme URL may be formed with any standard protocol name
   by concatenating "service:" and the reserved port [1] name. For
   example, "service:tftp://myhost" would indicate a tftp service. A
   tftp service on a nonstandard port could be
   "service:tftp://bad.glad.org:8080".

   Service Types SHOULD be defined by a "Service Template" [13], which
   provides expected attributes, values and protocol behavior. An
   abstract service type (also described in [13]) has the form

      "service:<abstract-type>:<concrete-type>".

   The service type string "service:<abstract-type>" matches all
   services of that abstract type. If the concrete type is included
   also, only these services match the request. For example: a SrvRqst
   or AttrRqst which specifies "service:printer" as the Service Type
   will match the URL service:printer:lpr://hostname and
   service:printer:http://hostname. If the requests specified
   "service:printer:http" they would match only the latter URL.

   An optional substring MAY follow the last '.' character in the
   <srvtype> (or <abstract-type> in the case of an abstract service type
   URL). This substring is the Naming Authority, as described in Section
   9.6. Service types with different Naming Authorities are quite
   distinct. In other words, service:x.one and service:x.two are
   different service types, as are service:abstract.one:y and
   service:abstract.two:y.

4.2. Naming Authorities

   A Naming Authority MAY optionally be included as part of the Service
   Type string. The Naming Authority of a service defines the meaning
   of the Service Types and attributes registered with and provided by
   Service Location. The Naming Authority itself is typically a string
   which uniquely identifies an organization. IANA is the implied
   Naming Authority when no string is appended. "IANA" itself MUST NOT
   be included explicitly.

   Naming Authorities may define Service Types which are experimental,
   proprietary or for private use. Using a Naming Authority, one may
   either simply ignore attributes upon registration or create a local-
   use only set of attributes for one's site. The procedure to use is
   to create a 'unique' Naming Authority string and then specify the
   Standard Attribute Definitions as described above. This Naming
   Authority will accompany registration and queries, as described in
   Sections 8.1 and 8.3. Service Types SHOULD be registered with IANA
   to allow for Internet-wide interoperability.

4.3. URL Entries

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   Reserved    |          Lifetime             |   URL Length  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |URL len, contd.|            URL (variable length)             \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |# of URL auths |         Auth. blocks (if any)                \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   SLP stores URLs in protocol elements called URL Entries, which
   associate a length, a lifetime, and possibly authentication
   information along with the URL. URL Entries, defined as shown above,
   are used in Service Replies and Service Registrations.

5. Service Attributes

   A service advertisement is often accompanied by Service Attributes.
   These attributes are used by UAs in Service Requests to select
   appropriate services.

   The allowable attributes which may be used are typically specified by
   a Service Template [13] for a particular service type. Services
   which are advertised according to a standard template MUST register
   all service attributes which the standard template requires. URLs
   with schemes other than "service:" MAY be registered with attributes.

Non-standard attribute names SHOULD begin with "x-", because no
standard attribute name will ever have those initial characters.

An attribute list is a string encoding of the attributes of a
service. The following ABNF [11] grammar defines attribute lists:

```
attr-list = attribute / attribute ',' attr-list
attribute = '(' attr-tag '=' attr-val-list ')' / attr-tag
attr-val-list = attr-val / attr-val ',' attr-val-list
attr-tag = 1*safe-tag
attr-val = intval / strval / boolval / opaque
intval = [-]1*DIGIT
strval = 1*safe-val
boolval = "true" / "false"
opaque = "\FF" 1*escape-val
safe-val = ; Any character except reserved.
safe-tag = ; Any character except reserved, star and bad-tag.
reserved = '(' / ')' / ',' / '\' / '!'  / '<' / '=' / '>' / '~' / CTL
escape-val = '\' HEXDIG HEXDIG
bad-tag = CR / LF / HTAB / '_'
 star = '*'
```

The <attr-list>, if present, MUST be scanned prior to evaluation for
all occurrences of the escape character '\'. Reserved characters
MUST be escaped (other characters MUST NOT be escaped). All escaped
characters must be restored to their value before attempting string
matching. For Opaque values, escaped characters are not converted -
they are interpreted as bytes.

    Boolean   Strings which have the form "true" or "false" can
                  only take one value and may only be compared with
                  '='. Booleans are case insensitive when compared.

    Integer   Strings which take the form [-] 1*<digit> and fall
                  in the range "-2147483648" to "2147483647" are
                  considered to be Integers. These are compared using
                  integer comparison.

    String   All other Strings are matched using strict lexical
                  ordering (see Section 6.4).

    Opaque   Opaque values are sequences of bytes. These are
                  distinguished from Strings since they begin with
                  the sequence "\FF". This, unescaped, is an illegal
                  UTF-8 encoding, indicating that what follows is a
                  sequence of bytes expressed in escape notation which
                  constitute the binary value. For example, a '0' byte
                  is encoded "\FF\00".

A string which contains escaped values other than from the reserved
set of characters is illegal. If such a string is included in an
<attr-list>, <tag-list> or search filter, the SA or DA which receives
it MUST return a PARSE_ERROR to the message.

A keyword has only an <attr-tag>, and no values. Attributes can have
one or multiple values. All values are expressed as strings.

When values have been advertised by a SA or are registered in a DA,
they can take on implicit typing rules for matching incoming
requests.

Stored values must be consistent, i.e., x=4,true,sue,\ff\00\00 is
disallowed. A DA or SA receiving such an <attr-list> MUST return an
INVALID_REGISTRATION error.

6. Required Features

This section defines the minimal implementation requirements for SAs
and UAs as well as their interaction with DAs. A DA is not required
for SLP to function, but if it is present, the UA and SA MUST
interact with it as defined below.

A minimal implementation may consist of either a UA or SA or both.
The only required features of a UA are that it can issue SrvRqsts
according to the rules below and interpret DAAdverts, SAAdverts and
SrvRply messages. The UA MUST issue requests to DAs as they are
discovered. An SA MUST reply to appropriate SrvRqsts with SrvRply or
SAAdvert messages. The SA MUST also register with DAs as they are
discovered.

UAs perform discovery by issuing Service Request messages. SrvRqst
messages are issued, using UDP, following these prioritized rules:

  1. A UA issues a request to a DA which it has been configured with
     by DHCP.

  2. A UA issues requests to DAs which it has been statically
     configured with.

  3. UA uses multicast/convergence SrvRqsts to discover DAs, then uses
     that set of DAs. A UA that does not know of any DAs SHOULD retry
     DA discovery, increasing the waiting interval between subsequent
     attempts exponentially (doubling the wait interval each time.)
     The recommended minimum waiting interval is CONFIG_DA_FIND
     seconds.

   4. A UA with no knowledge of DAs sends requests using multicast
      convergence to SAs. SAs unicast replies to UAs according to the
      multicast convergence algorithm.

   UAs and SAs are configured with a list of scopes to use according to
   these prioritized rules:

   1. With DHCP.

   2. With static configuration. The static configuration may be
      explicitly set to NO SCOPE for UAs, if the User Selectable Scope
      model is used. See section 11.2.

   3. In the absence of configuration, the agent's scope is "DEFAULT".

   A UA MUST issue requests with one or more of the scopes it has been
   configured to use.

   A UA which has been statically configured with NO SCOPE LIST will use
   DA or SA discovery to determine its scope list dynamically. In this
   case it uses an empty scope list to discover DAs and possibly SAs.
   Then it uses the scope list it obtains from DAAdverts and possibly
   SAAdverts in subsequent requests.

   The SA MUST register all its services with any DA it discovers, if
   the DA advertises any of the scopes it has been configured with. A
   SA obtains information about DAs as a UA does. In addition, the SA
   MUST listen for multicast unsolicited DAAdverts. The SA registers by
   sending SrvReg messages to DAs, which reply with SrvReg messages to
   indicate success. SAs register in ALL the scopes they were
   configured to use.

6.1. Use of Ports, UDP, and Multicast

   DAs MUST accept unicast requests and multicast directory agent
   discovery service requests (for the service type "service:directory-
   agent").

   SAs MUST accept multicast requests and unicast requests both. The SA
   can distinguish between them by whether the REQUEST MCAST flag is set
   in the SLP Message header.

   The Service Location Protocol uses multicast for discovering DAs and
   for issuing requests to SAs by default.

   The reserved listening port for SLP is 427. This is the destination
   port for all SLP messages. SLP messages MAY be transmitted on an
   ephemeral port. Replies and acknowledgements are sent to the port

from which the request was issued. The default maximum transmission
unit for UDP messages is 1400 bytes excluding UDP and other headers.

If a SLP message does not fit into a UDP datagram it MUST be
truncated to fit, and the OVERFLOW flag is set in the reply message.
A UA which receives a truncated message MAY open a TCP connection
(see section 6.2) with the DA or SA and retransmit the request, using
the same XID. It MAY also attempt to make use of the truncated reply
or reformulate a more restrictive request which will result in a
smaller reply.

SLP Requests messages are multicast to The Administratively Scoped
SLP Multicast [17] address, which is 239.255.255.253. The default
TTL to use for multicast is 255.

In isolated networks, broadcasts will work in place of multicast. To
that end, SAs SHOULD and DAs MUST listen for broadcast Service
Location messages at port 427. This allows UAs which do not support
multicast the use of Service Location on isolated networks.

Setting multicast TTL to less than 255 (the default) limits the range
of SLP discovery in a network, and localizes service information in
the network.

6.2. Use of TCP

A SrvReg or SrvDeReg may be too large to fit into a datagram. To
send such large SLP messages, a TCP (unicast) connection MUST be
established.

To avoid the need to implement TCP, one MUST insure that:

  - UAs never issue requests larger than the Path MTU. SAs can omit
    TCP support only if they never have to receive unicast requests
    longer than the path MTU.

  - UAs can accept replies with the 'OVERFLOW' flag set, and make use
    of the first result included, or reformulate the request.

  - Ensure that a SA can send a SrvRply, SrvReg, or SrvDeReg in
    a single datagram. This means limiting the size of URLs,
    the number of attributes and the number of authenticators
    transmitted.

DAs MUST be able to respond to UDP and TCP requests, as well as
multicast DA Discovery SrvRqsts. SAs MUST be able to respond to TCP
unless the SA will NEVER receive a request or send a reply which will
exceed a datagram in size (e.g., some embedded systems).

   A TCP connection MAY be used for a single SLP transaction, or for
   multiple transactions. Since there are length fields in the message
   headers, SLP Agents can send multiple requests along a connection and
   read the return stream for acknowledgments and replies.

   The initiating agent SHOULD close the TCP connection. The DA SHOULD
   wait at least CONFIG_CLOSE_CONN seconds before closing an idle
   connection. DAs and SAs SHOULD close an idle TCP connection after
   CONFIG_CLOSE_CONN seconds to ensure robust operation, even when the
   initiating agent neglects to close it. See Section 13 for timing
   rules.

6.3. Retransmission of SLP messages

   Requests which fail to elicit a response are retransmitted. The
   initial retransmission occurs after a CONFIG_RETRY wait period.
   Retransmissions MUST be made with exponentially increasing wait
   intervals (doubling the wait each time). This applies to unicast as
   well as multicast SLP requests.

   Unicast requests to a DA or SA should be retransmitted until either a
   response (which might be an error) has been obtained, or for
   CONFIG_RETRY_MAX seconds.

   Multicast requests SHOULD be reissued over CONFIG_MC_MAX seconds
   until a result has been obtained. UAs need only wait till they
   obtain the first reply which matches their request. That is,
   retransmission is not required if the requesting agent is prepared to
   use the 'first reply' instead of 'as many replies as possible within
   a bounded time interval.'

   When SLP SrvRqst, SrvTypeRqst, and AttrRqst messages are multicast,
   they contain a <PRList> of previous responders. Initially the
   <PRList> is empty. When these requests are unicast, the <PRList> is
   always empty.

   Any DA or SA which sees its address in the <PRList> MUST NOT respond
   to the request.

   The message SHOULD be retransmitted until the <PRList> causes no
   further responses to be elicited or the previous responder list and
   the request will not fit into a single datagram or until
   CONFIG_MC_MAX seconds elapse.

   UAs which retransmit a request use the same XID. This allows a DA or
   SA to cache its reply to the original request and then send it again,
   should a duplicate request arrive. This cached information should
   only be held very briefly. XIDs SHOULD be randomly chosen to avoid

   duplicate XIDs in requests if UAs restart frequently.

6.4. Strings in SLP messages

   The escape character is a backslash (UTF-8 0x5c) followed by the two
   hexadecimal digits of the escaped character. Only reserved
   characters are escaped. For example, a comma (UTF-8 0x29) is escaped
   as '\29', and a backslash '\' is escaped as '\5c'. String lists used
   in SLP define the comma to be the delimiter between list elements, so
   commas in data strings must be escaped in this manner. Backslashes
   are the escape character so they also must always be escaped when
   included in a string literally.

   String comparison for order and equality in SLP MUST be case
   insensitive inside the 0x00-0x7F subrange of UTF-8 (which corresponds
   to ASCII character encoding). Case insensitivity SHOULD be supported
   throughout the entire UTF-8 encoded Unicode [6] character set.

   The case insensitivity rule applies to all string matching in SLPv2,
   including Scope strings, SLP SPI strings, service types, attribute
   tags and values in query handling, language tags, previous responder
   lists. Comparisons of URL strings, however, is case sensitive.

   White space (SPACE, CR, LF, TAB) internal to a string value is folded
   to a single SPACE character for the sake of string comparisons.
   White space preceding or following a string value is ignored for the
   purposes of string comparison. For example, " Some String "
   matches "SOME   STRING".

   String comparisons (using comparison operators such as '<=' or '>=')
   are done using lexical ordering in UTF-8 encoded characters, not
   using any language specific rules.

   The reserved character '*' may precede, follow or be internal to a
   string value in order to indicate substring matching. The query
   including this character matches any character sequence which
   conforms to the letters which are not wildcarded.

6.4.1. Scope Lists in SLP

   Scope Lists in SLPv2 have the following grammar:

   scope-list = scope-val / scope-val ',' scope-list
   scope-val = 1*safe
    safe = ; Any character except reserved.
   reserved = '(' / ')' / ',' / '\' / '!' / '<' / '=' / '>' / '~' / CTL
         / ';' / '*' / '+'
   escape-val = '\' HEXDIG HEXDIG

Scopes which include any reserved characters must replace the escaped
character with the escaped-val format.

7. Errors

If the Error Code in a SLP reply message is nonzero, the rest of the
message MAY be truncated. No data is necessarily transmitted or
should be expected after the header and the error code, except
possibly for some optional extensions to clarify the error, for
example as in section D.1.

Errors are only returned for unicast requests. Multicast requests
are silently discarded if they result in an error.

LANGUAGE_NOT_SUPPORTED = 1: There is data for the service type in
        the scope in the AttrRqst or SrvRqst, but not in the requested
        language.
PARSE_ERROR = 2: The message fails to obey SLP syntax.
INVALID_REGISTRATION = 3: The SrvReg has problems -- e.g., a zero
        lifetime or an omitted Language Tag.
SCOPE_NOT_SUPPORTED = 4: The SLP message did not include a scope in
        its <scope-list> supported by the SA or DA.
AUTHENTICATION_UNKNOWN = 5: The DA or SA receives a request for an
        unsupported SLP SPI.
AUTHENTICATION_ABSENT = 6: The DA expected URL and ATTR
        authentication in the SrvReg and did not receive it.
AUTHENTICATION_FAILED = 7: The DA detected an authentication error in
        an Authentication block.
VER_NOT_SUPPORTED = 9: Unsupported version number in message header.
INTERNAL_ERROR = 10: The DA (or SA) is too sick to respond.
DA_BUSY_NOW = 11: UA or SA SHOULD retry, using exponential back off.
OPTION_NOT_UNDERSTOOD = 12: The DA (or SA) received an unknown option
        from the mandatory range (see section 9.1).
INVALID_UPDATE = 13: The DA received a SrvReg without FRESH set, for
        an unregistered service or with inconsistent Service Types.
MSG_NOT_SUPPORTED = 14: The SA received an AttrRqst or SrvTypeRqst
        and does not support it.
REFRESH_REJECTED = 15: The SA sent a SrvReg or partial SrvDereg to a
        DA more frequently than the DA's min-refresh-interval.

8. Required SLP Messages

All length fields in SLP messages are in network byte order. Where '
tuples' are defined, these are sequences of bytes, in the precise
order listed, in network byte order.

SLP messages all begin with the following header:

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |    Version    |  Function-ID  |            Length             |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    | Length, contd.|O|F|R|     reserved      |Next Ext Offset|
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |  Next Extension Offset, contd.|              XID              |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |      Language Tag Length      |         Language Tag          \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
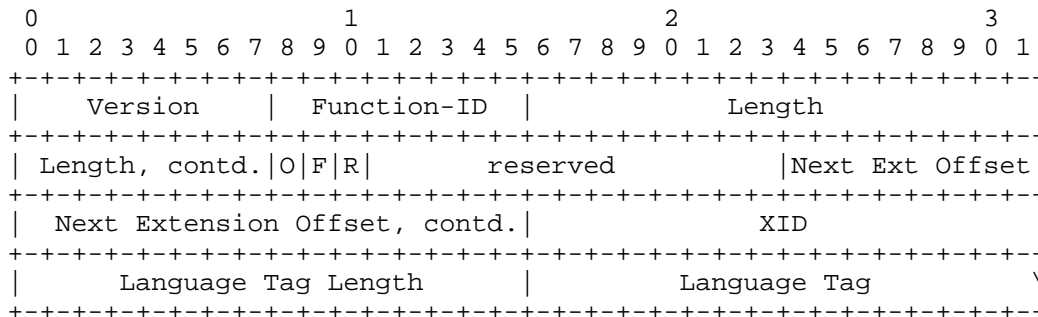
Message Type	Abbreviation	Function-ID
Service Request	SrvRqst	1
Service Reply	SrvRply	2
Service Registration	SrvReg	3
Service Deregister	SrvDeReg	4
Service Acknowledge	SrvAck	5
Attribute Request	AttrRqst	6
Attribute Reply	AttrRply	7
DA Advertisement	DAAdvert	8
Service Type Request	SrvTypeRqst	9
Service Type Reply	SrvTypeRply	10
SA Advertisement	SAAdvert	11

SAs and UAs MUST support SrvRqst, SrvRply and DAAdvert. SAs MUST
also support SrvReg, SAAdvert and SrvAck. For UAs and SAs, support
for other messages are OPTIONAL.

  - Length is the length of the entire SLP message, header included.
  - The flags are: OVERFLOW (0x80) is set when a message's length
    exceeds what can fit into a datagram. FRESH (0x40) is set on
    every new SrvReg. REQUEST MCAST (0x20) is set when multicasting
    or broadcasting requests. Reserved bits MUST be 0.
  - Next Extension Offset is set to 0 unless extensions are used.
    The first extension begins at 'offset' bytes, from the message's
    beginning. It is placed after the SLP message data. See
    Section 9.1 for how to interpret unrecognized SLP Extensions.
  - XID is set to a unique value for each unique request. If the
    request is retransmitted, the same XID is used. Replies set
    the XID to the same value as the xid in the request. Only
    unsolicited DAAdverts are sent with an XID of 0.
  - Lang Tag Length is the length in bytes of the Language Tag field.
  - Language Tag conforms to [7]. The Language Tag in a reply MUST
    be the same as the Language Tag in the request. This field must
    be encoded 1*8ALPHA *("-" 1*8ALPHA).

   If an option is specified, and not included in the message, the
   receiver MUST respond with a PARSE_ERROR.

8.1. Service Request

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        Service Location header (function = SrvRqst = 1)       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      length of <PRList>        |        <PRList> String       \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    length of <service-type>   |    <service-type> String     \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     length of <scope-list>    |     <scope-list> String      \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   length of predicate string  |  Service Request <predicate> \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   length of <SLP SPI> string  |       <SLP SPI> String       \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
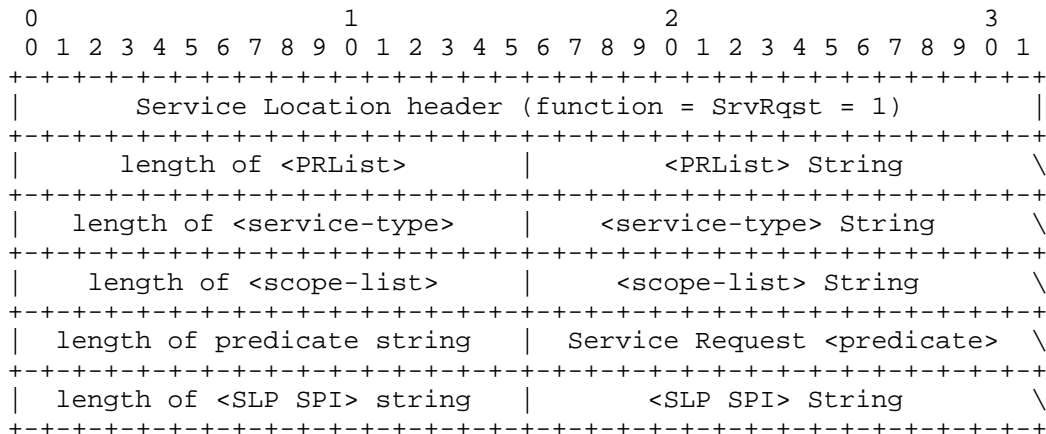
   In order for a Service to match a SrvRqst, it must belong to at least
   one requested scope, support the requested service type, and match
   the predicate. If the predicate is present, the language of the
   request (ignoring the dialect part of the Language Tag) must match
   the advertised service.

   <PRList> is the Previous Responder List. This <string-list> contains
   dotted decimal notation IP (v4) addresses, and is iteratively
   multicast to obtain all possible results (see Section 6.3). UAs
   SHOULD implement this discovery algorithm. SAs MUST use this to
   discover all available DAs in their scope, if they are not already
   configured with DA addresses by some other means.

   A SA silently drops all requests which include the SA's address in
   the <PRList>. An SA which has multiple network interfaces MUST check
   if any of the entries in the <PRList> equal any of its interfaces.
   An entry in the PRList which does not conform to an IPv4 dotted
   decimal address is ignored: The rest of the <PRList> is processed
   normally and an error is not returned.

   Once a <PRList> plus the request exceeds the path MTU, multicast
   convergence stops. This algorithm is not intended to find all
   instances; it finds 'enough' to provide useful results.

   The <scope-list> is a <string-list> of configured scope names. SAs
   and DAs which have been configured with any of the scopes in this
   list will respond. DAs and SAs MUST reply to unicast requests with a

SCOPE_NOT_SUPPORTED error if the <scope-list> is omitted or fails to
include a scope they support (see Section 11). The only exceptions
to this are described in Section 11.2.

The <service-type> string is discussed in Section 4. Normally, a
SrvRqst elicits a SrvRply. There are two exceptions: If the
<service-type> is set to "service:directory-agent", DAs respond to
the SrvRqst with a DAAdvert (see Section 8.5.) If set to
"service:service-agent", SAs respond with a SAAdvert (see Section
8.6.) If this field is omitted, a PARSE_ERROR is returned - as this
field is REQUIRED.

The <predicate> is a LDAPv3 search filter [14]. This field is
OPTIONAL. Services may be discovered simply by type and scope.
Otherwise, services are discovered which satisfy the <predicate>. If
present, it is compared to each registered service. If the attribute
in the filter has been registered with multiple values, the filter is
compared to each value and the results are ORed together, i.e.,
"(x=3)" matches a registration of (x=1,2,3); "(!(Y=0))" matches
(y=0,1) since Y can be nonzero. Note the matching is case
insensitive. Keywords (i.e., attributes without values) are matched
with a "presence" filter, as in "(keyword=*)".

An incoming request term MUST have the same type as the attribute in
a registration in order to match. Thus, "(x=33)" will not match '
x=true', etc. while "(y=foo)" will match 'y=FOO'.
"(|(x=33)(y=foo))" will be satisfied, even though "(x=33)" cannot be
satisfied, because of the '|' (boolean disjunction).

Wildcard matching MUST be done with the '=' filter. In any other
case, a PARSE_ERROR is returned. Request terms which include
wildcards are interpreted to be Strings. That is, (x=34*) would
match 'x=34foo', but not 'x=3432' since the first value is a String
while the second value is an Integer; Strings don't match Integers.

Examples of Predicates follow. <t> indicates the service type of the
SrvRqst, <s> gives the <scope-list> and <p> is the predicate string.

     <t>=service:http <s>=DEFAULT <p>= (empty string)
             This is a minimal request string. It matches all http
             services advertised with the default scope.

     <t>=service:pop3 <s>=SALES,DEFAULT <p>=(user=wump)
             This is a request for all pop3 services available in
             the SALES or DEFAULT scope which serve mail to the user
             'wump'.

```
      <t>=service:backup  <s>=BLDG 32  <p>=(&(q<=3)(speed>=1000))
               This returns the backup service which has a queue length
               less than 3 and a speed greater than 1000.  It will
               return this only for services registered with the BLDG 32
               scope.


      <t>=service:directory-agent  <s>=DEFAULT  <p>=
               This returns DAAdverts for all DAs in the DEFAULT scope.
```

   DAs are discovered by sending a SrvRqst with the service type set to
   "service:directory-agent". If a predicate is included in the
   SrvRqst, the DA SHOULD respond only if the predicate can be satisfied
   with the DA's attributes. The <scope-list> MUST contain all scopes
   configured for the UA or SA which is discovering DAs.

   The <SLP SPI> string indicates a SLP SPI that the requester has been
   configured with. If this string is omitted, the responder does not
   include any Authentication Blocks in its reply. If it is included,
   the responder MUST return a reply which has an associated
   authentication block with the SLP SPI in the SrvRqst. If no replies
   may be returned because the SLP SPI is not supported, the responder
   returns an AUTHENTICATION_UNKNOWN error.

8.2. Service Reply

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |        Service Location header (function = SrvRply = 2)       |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |        Error Code            |        URL Entry count         |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |       <URL Entry 1>          ...        <URL Entry N>         \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
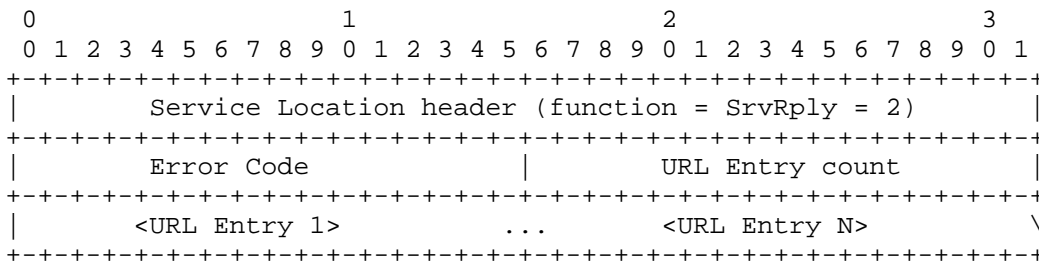
   The service reply contains zero or more URL entries (see Section
   4.3). A service reply with zero URL entries MUST be returned in
   response to a unicast Service Request, if no matching URLs are
   present. A service reply with zero URL entries MUST NOT be sent in
   response to a multicast or broadcast service request (instead, if
   there was no match found or an error processing the request, the
   service reply should not be generated at all).

   If the reply overflows, the UA MAY simply use the first URL Entry in
   the list. A URL obtained by SLP may not be cached longer than
   Lifetime seconds, unless there is a URL Authenticator block present.

In that case, the cache lifetime is indicated by the Timestamp in the URL Authenticator (see Section 9.2).

An authentication block is returned in the URL Entries, including the SLP SPI in the SrvRqst. If no SLP SPI was included in the request, no Authentication Blocks are returned in the reply.   URL Authentication Blocks are defined in Section 9.2.1.

If a SrvRply is sent by UDP, a URL Entry MUST NOT be included unless it fits entirely without truncation.

8.3. Service Registration

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Service Location header (function = SrvReg = 3)      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          <URL-Entry>                          \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| length of service type string |         <service-type>       \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     length of <scope-list>    |          <scope-list>         \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   length of attr-list string  |           <attr-list>         \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|# of AttrAuths |(if present) Attribute Authentication Blocks...\
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
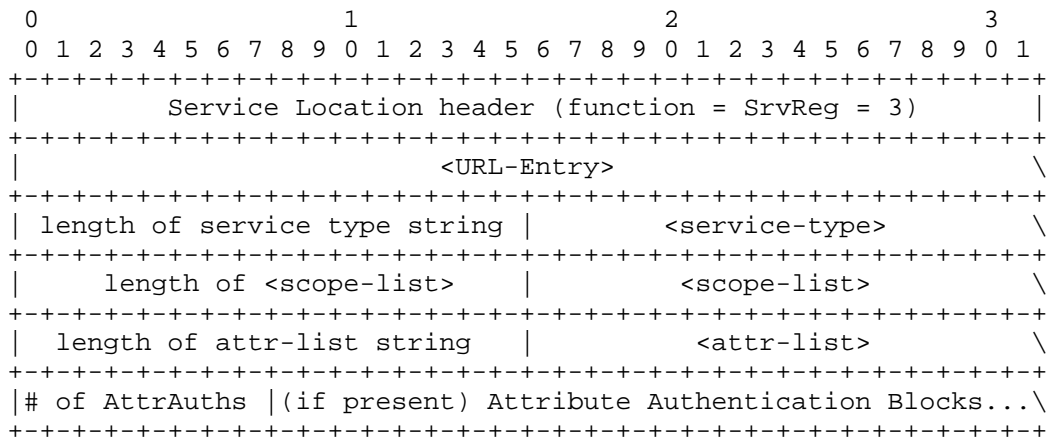
The <entry> is a URL Entry (see section 4.3). The Lifetime defines how long a DA can cache the registration. SAs SHOULD reregister before this lifetime expires (but SHOULD NOT more often than once per second). The Lifetime MAY be set to any value between 0 and 0xffff (maximum, around 18 hours). Long-lived registrations remain stale longer if the service fails and the SA does not deregister the service.

The <service-type> defines the service type of the URL to be registered, regardless of the scheme of the URL. The <scope-list> MUST contain the names of all scopes configured for the SA, which the DA it is registering with supports. The default value for the <scope-list> is "DEFAULT" (see Section 11).

The SA MUST register consistently with all DAs. If a SA is configured with scopes X and Y and there are three DAs, whose scopes are "X", "Y" and "X,Y" respectively, the SA will register the with all three DAs in their respective scopes. All future updates and deregistrations of the service must be sent to the same set of DAs in

the same scopes the service was initially registered in.

The <attr-list>, if present, specifies the attributes and values to
be associated with the URL by the DA (see Section 5).

A SA configured with the ability to sign service registrations MUST
sign each of the URLs and Attribute Lists using each of the keys it
is configured to use, and the DA it is registering with accepts.
(The SA MUST acquire DAAdverts for all DAs it will register with to
obtain the DA's SLP SPI list and attributes, as described in Section
8.5). The SA supplies a SLP SPI in each authentication block
indicating the SLP SPI configuration required to verify the digital
signature. The format of the digital signatures used is defined in
section 9.2.1.

Subsequent registrations of previously registered services MUST
contain the same list of SLP SPIs as previous ones or else DAs will
reject them, replying with an AUTHENTICATION_ABSENT error.

A registration with the FRESH flag set will replace *entirely* any
previous registration for the same URL in the same language. If the
FRESH flag is not set, the registration is an "incremental"
registration (see Section 9.3).

8.4. Service Acknowledgment

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          Service Location header (function = SrvAck = 5)      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          Error Code           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
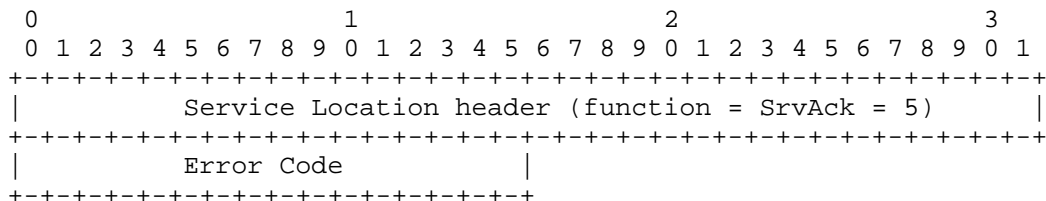
A DA returns a SrvAck to an SA after a SrvReg. It carries only a two
byte Error Code (see Section 7).

8.5. Directory Agent Advertisement

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |         Service Location header (function = DAAdvert = 8)     |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |          Error Code           |  DA Stateless Boot Timestamp  |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |DA Stateless Boot Time,, contd.|         Length of URL         |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    \                              URL                              \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |     Length of <scope-list>    |         <scope-list>          \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |     Length of <attr-list>     |         <attr-list>           \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |    Length of <SLP SPI List>   |      <SLP SPI List> String    \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    | # Auth Blocks |        Authentication block (if any)          \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
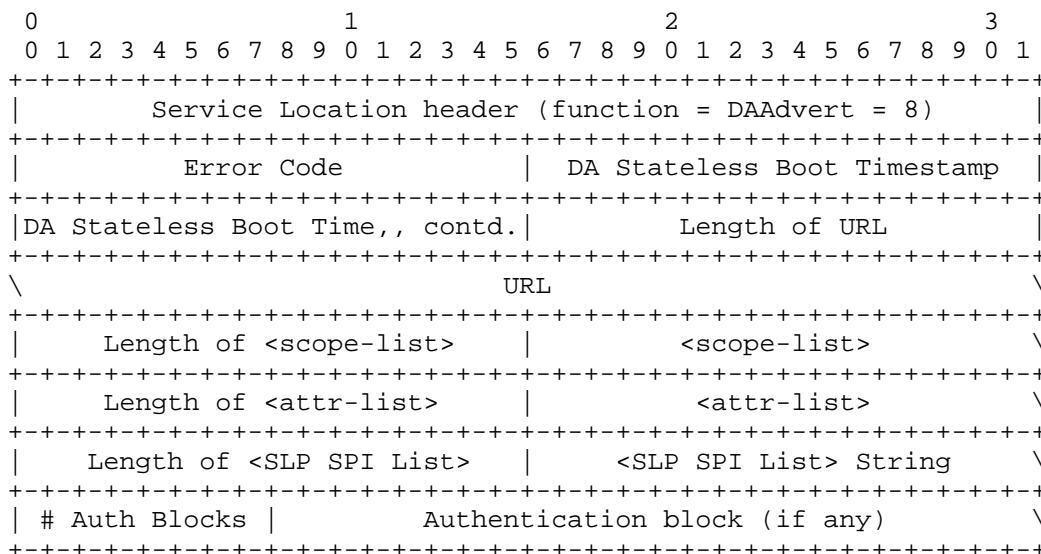
The Error Code is set to 0 when the DAAdvert is multicast. If the
DAAdvert is being returned due to a unicast SrvRqst (ie. a request
without the REQUEST MCAST flag set) the DA returns the same errors a
SrvRply would.

The <scope-list> of the SrvRqst must either be omitted or include a
scope which the DA supports. The DA Stateless Boot Timestamp
indicates the state of the DA (see section 12.1).

The DA MAY include a list of its attributes in the DAAdvert. This
list SHOULD be kept short, as the DAAdvert must fit into a datagram
in order to be multicast.

A potential scaling problem occurs in SLPv2 if SAs choose too low a
Lifetime. In this case, an onerous amount of reregistration occurs
as more services are deployed. SLPv2 allows DAs to control SAs
frequency of registration. A DA MAY reissue a DAAdvert with a new
set of attributes at any time, to change the reregistration behavior
of SAs. These apply only to subsequent registrations; existing
service registrations with the DA retain their registered lifetimes.

If the DAAdvert includes the attribute "min-refresh-interval" it MUST
be set to a single Integer value indicating a number of seconds. If
this attribute is present SAs MUST NOT refresh any particular service
advertisement more frequently than this value. If SrvReg with the
FRESH FLAG not set or SrvDereg with a non-empty tag list updating a

particular service are received more often than the value for the
DA's advertised "min-refresh-interval" attribute the DA SHOULD reject
the message and return a REFRESH_REJECTED error in the SrvAck.

The URL is "service:directory-agent://"<addr> of the DA, where <addr>
is the dotted decimal numeric address of the DA. The <scope-list> of
the DA MUST NOT be NULL.

The SLP SPI List is the list of SPIs that the DA is capable of
verifying. SAs MUST NOT register services with authentication blocks
for those SLP SPIs which are not on the list. DAs will reject
service registrations which they cannot verify, returning an
AUTHENTICATION_UNKNOWN error.

The format of DAAdvert signatures is defined in Section 9.2.1.

The SLP SPI which is used to verify the DAAdvert is included in the
Authentication Block. When DAAdverts are multicast, they may have to
transmit multiple DAAdvert Authentication Blocks. If the DA is
configured to be able to generate signatures for more than one SPI,
the DA MUST include one Authentication Block for each SPI. If all
these Authentication Blocks do not fit in a single datagram (to
multicast or broadcast) the DA MUST send separate DAAdverts so that
Authentication Blocks for all the SPIs the DA is capable of
generating are sent.

If the DAAdvert is being sent in response to a SrvRqst, the DAAdvert
contains only the authentication block with the SLP SPI in the
SrvRqst, if the DA is configured to be able to produce digital
signatures using that SLP SPI. If the SrvRqst is unicast to the DA
(the REQUEST MCAST flag in the header is not set) and an unsupported
SLP SPI is included, the DA replies with a DAAdvert with the Error
Code set to an AUTHENTICATION_UNKNOWN error.

UAs SHOULD be configured with SLP SPIs that will allow them to verify
DA Advertisements. If the UA is configured with SLP SPIs and
receives a DAAdvert which fails to be verified using one of them, the
UA MUST discard it.

8.6. Service Agent Advertisement

User Agents MUST NOT solicit SA Advertisements if they have been
configured to use a particular DA, if they have been configured with
a <scope-list> or if DAs have been discovered. UAs solicit SA
Advertisements only when they are explicitly configured to use User
Selectable scopes (see Section 11.2) in order to discover the scopes
that SAs support. This allows UAs without scope configuration to
make use of either DAs or SAs without any functional difference

except performance.

A SA MAY be configured with attributes, and SHOULD support the
attribute 'service-type' whose value is all the service types of
services represented by the SA. SAs MUST NOT respond if the SrvRqst
predicate is not satisfied. For example, only SAs offering 'nfs'
services SHOULD respond with a SAAdvert to a SrvRqst for service type
"service:service-agent" which includes a predicate "(service-
type=nfs)".

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        Service Location header (function = SAAdvert = 11)     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         Length of URL          |              URL             \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Length of <scope-list>     |          <scope-list>        \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Length of <attr-list>      |           <attr-list>        \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | # auth blocks |        authentication block (if any)          \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
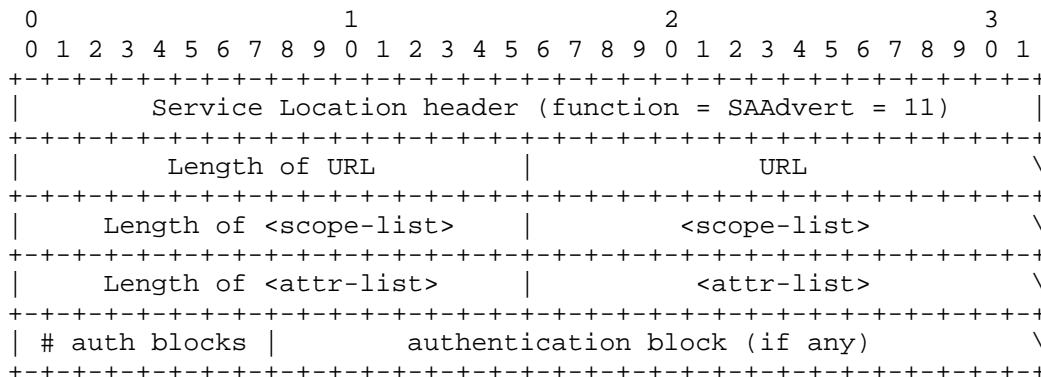
The SA responds only to multicast SA discovery requests which either
include no <scope-list> or a scope which they are configured to use.

The SAAdvert MAY include a list of attributes the SA supports. This
attribute list SHOULD be kept short so that the SAAdvert will not
exceed the path MTU in size.

The URL is "service:service-agent://"<addr> of the SA, where <addr>
is the dotted decimal numeric address of the SA. The <scope-list> of
the SA MUST NOT be null.

The SAAdvert contains one SAAdvert Authentication block for each SLP
SPI the SA can produce Authentication Blocks for. If the UA can
verify the Authentication Block of the SAAdvert, and the SAAdvert
fails to be verified, the UA MUST discard it.

9. Optional Features

The features described in this section are not mandatory. Some are
useful for interactive use of SLP (where a user rather than a program
will select services, using a browsing interface for example) and for
scalability of SLP to larger networks.

9.1. Service Location Protocol Extensions

   The format of a Service Location Extension is:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         Extension ID          |       Next Extension Offset   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Offset, contd.|                Extension Data                 \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
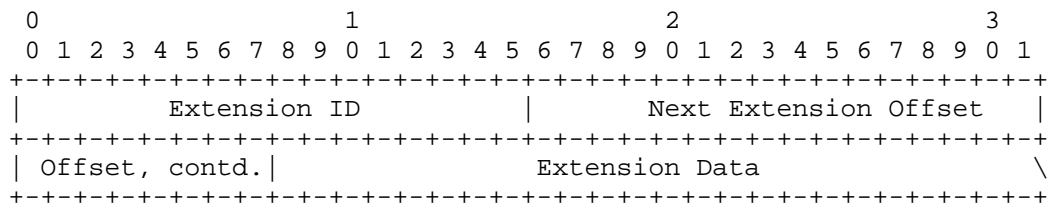
   Extension IDs are assigned in the following way:

   0x0000-0x3FFF Standardized. Optional to implement. Ignore if
        unrecognized.
   0x4000-0x7FFF Standardized. Mandatory to implement. A UA or SA
        which receives this option in a reply and does not understand
        it MUST silently discard the reply. A DA or SA which receives
        this option in a request and does not understand it MUST return
        an OPTION_NOT_UNDERSTOOD error.
   0x8000-0x8FFF For private use (not standardized). Optional to
        implement. Ignore if unrecognized.
   0x9000-0xFFFF Reserved.

   The three byte offset to next extension indicates the position of the
   next extension as offset from the beginning of the SLP message.

   The offset value is 0 if there are no extensions following the
   current extension.

   If the offset is 0, the length of the current Extension Data is
   determined by subtracting total length of the SLP message as given in
   the SLP message header minus the offset of the current extension.

   Extensions defined in this document are in Section D. See section 15
   for procedures that are required when specifying new SLP extensions.

9.2. Authentication Blocks

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |  Block Structure Descriptor   |  Authentication Block Length  |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                           Timestamp                           |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |      SLP SPI String Length     |        SLP SPI String        \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |               Structured Authentication Block ...             \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
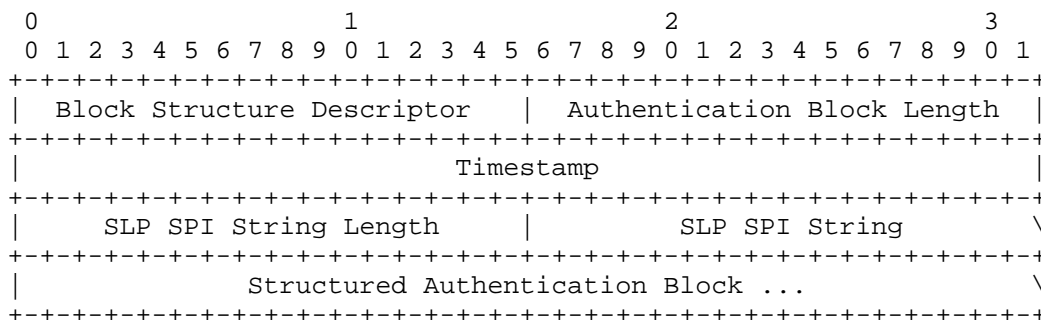
Authentication blocks are returned with certain SLP messages to
verify that the contents have not been modified, and have been
transmitted by an authorized agent. The authentication data
(contained in the Structured Authentication Block) is typically case
sensitive. Even though SLP registration data (e.g., attribute
values) are typically are not case sensitive, the case of the
registration data has to be preserved by the registering DA so that
UAs will be able to verify the data used for calculating digital
signature data.

The Block Structure Descriptor (BSD) identifies the format of the
Authenticator which follows. BSDs 0x0000-0x7FFF will be maintained
by IANA. BSDs 0x8000-0x8FFF are for private use.

The Authentication Block Length is the length of the entire block,
starting with the BSD.

The Timestamp is the time that the authenticator expires (to prevent
replay attacks.) The Timestamp is a 32-bit unsigned fixed-point
number of seconds relative to 0h on 1 January 1970. SAs use this
value to indicate when the validity of the digital signature expires.
This Timestamp will wrap back to 0 in the year 2106. Once the value
of the Timestamp wraps, the time at which the Timestamp is relative
to resets. For example, after 06h28 and 16 seconds 5 February 2106,
all Timestamp values will be relative to that epoch date.

The SLP Security Parameters Index (SPI) string identifies the key
length, algorithm parameters and keying material to be used by agents
to verify the signature data in the Structured Authentication Block.
The SLP SPI string has the same grammar as the <scope-val> defined in
Section 6.4.1.

Reserved characters in SLP SPI strings must be escaped using the same
convention as used throughout SLPv2.

SLP SPIs deployed in a site MUST be unique. An SLP SPI used for
BSD=0x0002 must not be the same as used for some other BSD.

All SLP agents MUST implement DSA [20] (BSD=0x0002). SAs MUST
register services with DSA authentication blocks, and they MAY
register them with other authentication blocks using other
algorithms. SAs MUST use DSA authentication blocks in SrvDeReg
messages and DAs MUST use DSA authentication blocks in unsolicited
DAAdverts.

9.2.1. SLP Message Authentication Rules

The sections below define how to calculate the value to apply to the
algorithm identified by the BSD value. The components listed are
used as if they were a contiguous single byte aligned buffer in the
order given.

    URL
        16-bit Length of SLP SPI String, SLP SPI String.
        16-bit Length of URL, URL,
        32-bit Timestamp.

    Attribute List
        16-bit Length of SLP SPI String, SLP SPI String,
        16-bit length of <attr-list>, <attr-list>,
        32-bit Timestamp.

    DAAdvert
        16-bit Length of SLP SPI String, SLP SPI String,
        32-bit DA Stateless Boot Timestamp,
        16-bit Length of URL, URL,
        16-bit Length of <attr-list>, <attr-list>,
        16-bit Length of DA's <scope-list>, DA's <scope-list>,
        16-bit Length of DA's <SLP SPI List>, DA's <SLP SPI List>,
        32-bit Timestamp.

        The first SLP SPI is the SLP SPI in the Authentication
        Block. This SLP SPI indicates the keying material and other
        parameters to use to verify the DAAdvert. The SLP SPI List is
        the list of SLP SPIs the DA itself supports, and is able to
        verify.

    SAAdvert
        16-bit Length of SLP SPI String, SLP SPI String,
        16-bit Length of URL, URL,
        16-bit Length of <attr-list>, <attr-list>,
        16-bit Length of <scope-list>, <scope-list>,
        32-bit Timestamp.

9.2.2 DSA with SHA-1 in Authentication Blocks

   BSD=0x0002 is defined to be DSA with SHA-1. The signature
   calculation is defined by [20]. The signature format conforms to
   that in the X.509 v3 certificate:

    1. The signature algorithm identifier (an OID)
    2. The signature value (an octet string)
    3. The certificate path.

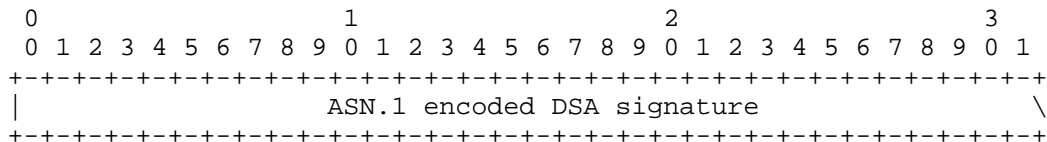   All data is represented in ASN.1 encoding:

        id-dsa-with-sha1 ID ::= {
                      iso(1) member-body(2) us(840) x9-57 (10040)
                      x9cm(4) 3 }

   i.e., the ASN.1 encoding of 1.2.840.10040.4.3 followed immediately
   by:

        Dss-Sig-Value ::= SEQUENCE {
                      r   INTEGER,
                      s   INTEGER }

   i.e., the binary ASN.1 encoding of r and s computed using DSA and
   SHA-1. This is followed by a certificate path, as defined by X.509
   [10], [2], [3], [4], [5].

   Authentication Blocks for BSD=0x0002 have the following format. In
   the future, BSDs may be assigned which have different formats.

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                   ASN.1 encoded DSA signature               \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

9.3. Incremental Service Registration

   Incremental registrations update attribute values for a previously
   registered service. Incremental service registrations are useful
   when only a single attribute has changed, for instance. In an
   incremental registration, the FRESH flag in the SrvReg header is NOT
   set.

   The new registration's attributes replace the previous
   registration's, but do not affect attributes which were included
   previously and are not present in the update.

   For example, suppose service:x://a.org has been registered with
   attributes A=1, B=2, C=3. If an incremental registration comes for
   service:x://a.org with attributes C=30, D=40, then the attributes for
   the service after the update are A=1, B=2, C=30, D=40.

   Incremental registrations MUST NOT be performed for services
   registered with Authentication Blocks. These must be registered with
   ALL attributes, with the FRESH flag in the SrvReg header set. DAs
   which receive such registration messages return an
   AUTHENTICATION_FAILED error.

   If the FRESH flag is not set and the DA does not have a prior
   registration for the service, the incremental registration fails with
   error code INVALID_UPDATE.

   The SA MUST use the same <scope-list> in an update message as was
   used in the prior registration. If this is not done, the DA returns
   a SCOPE_NOT_SUPPORTED error. In order to change the scope of a
   service advertisement it MUST be deregistered first and reregistered
   with a new <scope-list>.

   The SA MUST use the same <service-type> in an update message as was
   used in a prior registration of the same URL. If this is not done,
   the DA returns an INVALID_UPDATE error.

9.4. Tag Lists

   Tag lists are used in SrvDeReg and AttrReq messages. The syntax of a
   <tag-list> item is:

   tag-filter = simple-tag / substring
   simple-tag = 1*filt-char
   substring = [initial] any [final]
   initial = 1*filt-char
     any = '*' *(filt-char '*')
   final = 1*filt-char
   filt-char = Any character excluding <reserved> and <bad-tag> (see
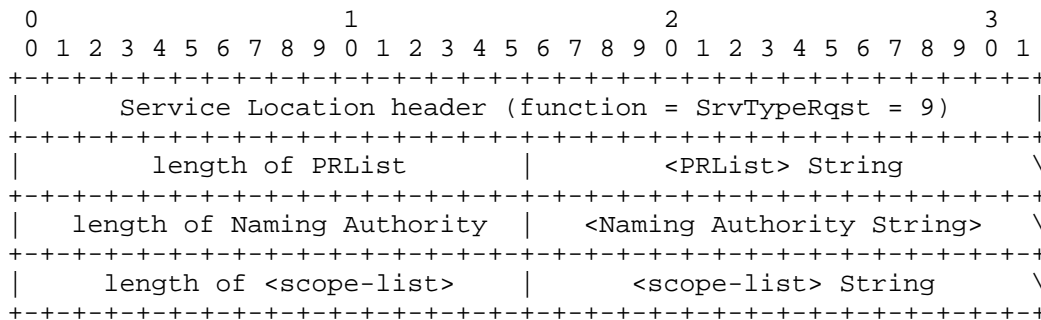   grammar in Section 5).

   Wild card characters in a <tag-list> item match arbitrary sequences
   of characters. For instance "*bob*" matches "some bob I know",
   "bigbob", "bobby" and "bob".

10. Optional SLP Messages

   The additional requests provide features for user interaction and for
   efficient updating of service advertisements with dynamic attributes.
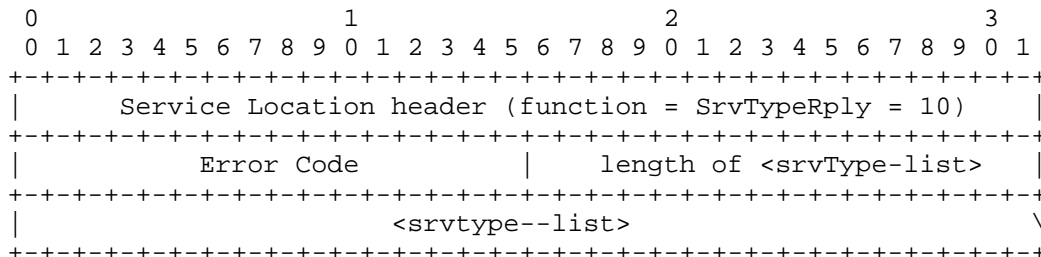
10.1. Service Type Request

   The Service Type Request (SrvTypeRqst) allows a UA to discover all
   types of service on a network. This is useful for general purpose
   service browsers.

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Service Location header (function = SrvTypeRqst = 9)     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        length of PRList        |        <PRList> String       \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   length of Naming Authority   |   <Naming Authority String>  \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      length of <scope-list>    |      <scope-list> String     \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

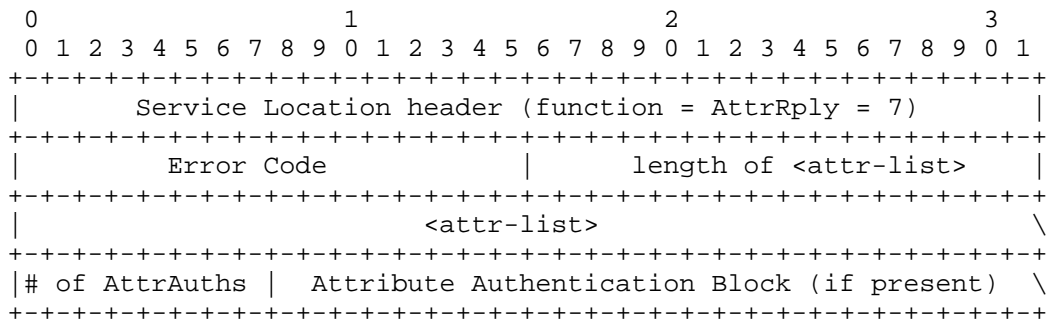   The <PRList> list and <scope-list> are interpreted as in Section 8.1.

   The Naming Authority string, if present in the request, will limit
   the reply to Service Type strings with the specified Naming
   Authority. If the Naming Authority string is absent, the IANA
   registered service types will be returned. If the length of the
   Naming Authority is set to 0xFFFF, the Naming Authority string is
   omitted and ALL Service Types are returned, regardless of Naming
   Authority.

10.2. Service Type Reply

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Service Location header (function = SrvTypeRply = 10)    |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Error Code           |    length of <srvType-list>  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        <srvtype--list>                        \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   The service-type Strings (as described in Section 4.1) are provided
   in <srvtype-list>, which is a <string-list>.

   If a service type has a Naming Authority other than IANA it MUST be
   returned following the service type string and a '.' character.
   Service types with the IANA Naming Authority do not include a Naming
   Authority string.

10.3. Attribute Request

   The Attribute Request (AttrRqst) allows a UA to discover attributes
   of a given service (by supplying its URL) or for an entire service
   type. The latter feature allows the UA to construct a query for an
   available service by selecting desired features. The UA may request
   that all attributes are returned, or only a subset of them.

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |       Service Location header (function = AttrRqst = 6)        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |       length of PRList        |        <PRList> String        \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         length of URL         |              URL              \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     length of <scope-list>    |       <scope-list> string     \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   length of <tag-list> string |        <tag-list> string      \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    length of <SLP SPI> string |        <SLP SPI> string       \
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   The <PRList>, <scope-list> and <SLP SPI> string are interpreted as in
   Section 8.1.

   The URL field can take two forms. It can simply be a Service Type
   (see Section 4.1), such as "http" or "service:tftp". In this case,
   all attributes and the full range of values for each attribute of all
   services of the given Service Type is returned.

   The URL field may alternatively be a full URL, such as
   "service:printer:lpr://igore.wco.ftp.com:515/draft" or
   "nfs://max.net/znoo". In this, only the registered attributes for
   the specified URL are returned.

   The <tag-list> field is a <string-list> of attribute tags, as defined
   in Section 9.4 which indicates the attributes to return in the
   AttrRply. If <tag-list> is omitted, all attributes are returned.
   <tag-list> MUST be omitted and a full URL MUST be included when
   attributes when a SLP SPI List string is included, otherwise the DA
   will reply with an AUTHENTICATION_FAILED error.

10.4. Attribute Reply

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |         Service Location header (function = AttrRply = 7)      |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |           Error Code          |      length of <attr-list>    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                         <attr-list>                           \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |# of AttrAuths |  Attribute Authentication Block (if present)  \
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   The format of the <attr-list> and the Authentication Block is as
   specified for SrvReg (see Section 9.2.1).

   Attribute replies SHOULD be returned with the original case of the
   string registration intact, as they are likely to be human readable.
   In the case where the AttrRqst was by service type, all attributes
   defined for the service type, and all their values are returned.

   Although white space is folded for string matching, attribute tags
   and values MUST be returned with their original white space
   preserved.

   Only one copy of each attribute tag or String value should be
   returned, arbitrarily choosing one version (with respect to upper and
   lower case and white space internal to the strings): Duplicate
   attributes and values SHOULD be removed. An arbitrary version of the
   string value and tag name is chosen for the merge. For example:
   "(A=a a,b)" merged with "(a=A   A,B)" may yield "(a=a a,B)".

10.5. Attribute Request/Reply Examples

   Suppose that printer services have been registered as follows:

   Registered Service:
     URL   = service:printer:lpr://igore.wco.ftp.com/draft
     scope-list = Development
     Lang. Tag = en
     Attributes = (Name=Igore),(Description=For developers only),
                  (Protocol=LPR),(location-description=12th floor),
                  (Operator=James Dornan \3cdornan@monster\3e),
                  (media-size=na-letter),(resolution=res-600),x-OK

     URL   = service:printer:lpr://igore.wco.ftp.com/draft
     scope-list = Development

```
     Lang. Tag  = de
     Attributes = (Name=Igore),(Description=Nur fuer Entwickler),
                  (Protocol=LPR),(location-description=13te Etage),
                  (Operator=James Dornan \3cdornan@monster\3e),
                  (media-size=na-letter),(resolution=res-600),x-OK

     URL        = service:printer:http://not.wco.ftp.com/cgi-bin/pub-prn
     scope-list = Development
     Lang. Tag  = en
     Attributes = (Name=Not),(Description=Experimental IPP printer),
                  (Protocol=http),(location-description=QA bench),
                  (media-size=na-letter),(resolution=other),x-BUSY
```

   Notice the first printer, "Igore" is registered in both English and
   German. The '<' and '>' characters in the Operator attribute value
   which are part of the Email address had to be escaped, as they are
   reserved characters for values.

   Attribute tags are not translated, though attribute values may be,
   see [13].

   The attribute Request:

```
     URL        = service:printer:lpr://igore.wco.ftp.com/draft
     scope-list = Development
     Lang. Tag  = de
     tag-list   = resolution,loc*
```

   receives the Attribute Reply:

```
     (location-description=13te Etage),(resolution=res-600)
```

   The attribute Request:

```
     URL        = service:printer
     scope-list = Development
     Lang. Tag  = en
     tag-list   = x-*,resolution,protocol
```

   receives an Attribute Reply containing:

```
     (protocols=http,LPR),(resolution=res-600,other),x-OK,x-BUSY
```

   The first request is by service instance and returns the requested
   values, in German. The second request is by abstract service type
   (see Section 4) and returns values from both "Igore" and "Not".

An attribute Authentication Block is returned if an authentication
block with the SLP SPI in the AttrRqst can be returned. Note that
the <attr-list> returned from a DA with an Authentication Block MUST
be identical to the <attr-list> registered by a SA, in order for the
authentication verification calculations to be possible.

A SA or DA only returns an Attribute Authentication Block if the
AttrRqst included a full URL in the request and no tag list.

If an SLP SPI is specified in a unicast request (the REQUEST MCAST
flag in the header is not set) and the SA or DA cannot return an
Authentication Block with that SLP SPI, an AUTHENTICATION_UNKNOWN
error is returned. The # of Attr Auths field is set to 0 if there no
Authentication Block is included, or 1 if an Authentication Block
follows.

10.6. Service Deregistration

A DA deletes a service registration when its Lifetime expires.
Services SHOULD be deregistered when they are no longer available,
rather than leaving the registrations to time out.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Service Location header (function = SrvDeReg = 4)     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Length of <scope-list>    |         <scope-list>         \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            URL Entry                          \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Length of <tag-list>     |            <tag-list>         \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
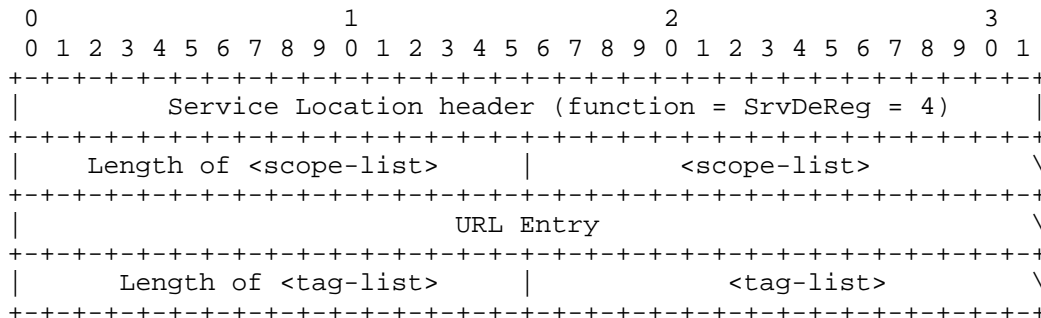
The <scope-list> is a <string-list> (see section 2.1).

The SA MUST retry if there is no response from the DA, see Section
12.3. The DA acknowledges a SrvDeReg with a SrvAck. Once the SA
receives an acknowledgment indicating success, the service and/or
attributes are no longer advertised by the DA. The DA deregisters the
service or service attributes from every scope specified in the
SrvDeReg which it was previously registered in.

The SA MUST deregister all services with the same scope list used to
register the service with a DA. If this is not done in the SrvDeReg
message, the DA returns a SCOPE_NOT_SUPPORTED error. The Lifetime
field in the URL Entry is ignored for the purposes of the SrvDeReg.

The <tag-list> is a <string-list> of attribute tags to deregister as
defined in Section 9.4. If no <tag-list> is present, the SrvDeReg
deregisters the service in all languages it has been registered in.
If the <tag-list> is present, the SrvDeReg deregisters the attributes
whose tags are listed in the tag spec. Services registered with
Authentication Blocks MUST NOT include a <tag-list> in a SrvDeReg
message: A DA will respond with an AUTHENTICATION_FAILED error in
this case.

If the service to be deregistered was registered with an
authentication block or blocks, a URL authentication block for each
of the SLP SPIs registered must be included in the SrvDeReg.
Otherwise, the DA returns an AUTHENTICATION_ABSENT error. If the
message fails to be verified by the DA, an AUTHENTICATION_FAILED
error is returned by the DA.

11. Scopes

Scopes are sets of services. The primary use of Scopes is to provide
the ability to create administrative groupings of services. A set of
services may be assigned a scope by network administrators. A client
seeking services is configured to use one or more scopes. The user
will only discover those services which have been configured for him
or her to use. By configuring UAs and SAs with scopes,
administrators may provision services. Scopes strings are case
insensitive. The default SCOPE string is "DEFAULT".

Scopes are the primary means an administrator has to scale SLP
deployments to larger networks. When DAs with NON-DEFAULT scopes are
present on the network, further gains can be had by configuring UAs
and SAs to have a predefined non-default scope. These agents can
then perform DA discovery and make requests using their scope. This
will limit the number of replies.

11.1. Scope Rules

SLP messages which fail to contain a scope that the receiving Agent
is configured to use are dropped (if the request was multicast) or a
SCOPE_NOT_SUPPORTED error is returned (if the request was unicast).
Every SrvRqst (except for DA and SA discovery requests), SrvReg,
AttrRqst, SrvTypeRqst, DAAdvert, and SAAdvert message MUST include a
<scope-list>.

A UA MUST unicast its SLP messages to a DA which supports the desired
scope, in preference to multicasting a request to SAs. A UA MAY
multicast the request if no DA is available in the scope it is
configured to use.

11.2. Administrative and User Selectable Scopes

   All requests and services are scoped. The two exceptions are
   SrvRqsts for "service:directory-agent" and "service:service-agent".
   These MAY have a zero-length <scope-list> when used to enable the
   user to make scope selections. In this case UAs obtain their scope
   list from DAAdverts (or if DAs are not available, from SAAdverts.)

   Otherwise, if SAs and UAs are to use any scope other than the default
   (i.e., "DEFAULT"), the UAs and SAs are configured with lists of
   scopes to use by system administrators, perhaps automatically by way
   of DHCP option 78 or 79 [21]. Such administrative scoping allows
   services to be provisioned, so that users will only see services they
   are intended to see.

   User configurable scopes allow a user to discover any service, but
   require them to do their own selection of scope. This is similar to
   the way AppleTalk [12] and SMB [19] networking allow user selection
   of AppleTalk Zone or workgroups.

   Note that the two configuration choices are not compatible. One
   model allows administrators control over service provision. The
   other delegates this to users (who may not be prepared to do any
   configuration of their system).

12. Directory Agents

   DAs cache service location and attribute information. They exist to
   enhance the performance and scalability of SLP. Multiple DAs provide
   further scalability and robustness of operation, since they can each
   store service information for the same SAs, in case one of the DAs
   fails.

   A DA provides a centralized store for service information. This is
   useful in a network with several subnets or with many SLP Agents.
   The DA address can be dynamically configured with UAs and SAs using
   DHCP, or by using static configuration.

   SAs configured to use DAs with DHCP or static configuration MUST
   unicast a SrvRqst to the DA, when the SA is initialized. The SrvRqst
   omits the scope list and sets the service type of the request to
   "service:directory-agent". The DA will return a DAAdvert with its
   attributes, SLP SPI list, and other parameters which are essential
   for proper SA to DA communication.

   Passive detection of DAs by SAs enables services to be advertised
   consistently among DAs of the same scope. Advertisements expire if
   not renewed, leaving only transient stale registrations in DAs, even

in the case of a failure of a SA.

A single DA can support many UAs. UAs send the same requests to DAs
that they would send to SAs and expect the same results. DAs reduce
the load on SAs, making simpler implementations of SAs possible.

UAs MUST be prepared for the possibility that the service information
they obtain from DAs is stale.

12.1. Directory Agent Rules

When DAs are present, each SA MUST register its services with DAs
that support one or more of its scope(s).

UAs MUST unicast requests directly to a DA (when scoping rules
allow), hence avoiding using the multicast convergence algorithm, to
obtain service information. This decreases network utilization and
increases the speed at which UAs can obtain service information.

DAs MUST flush service advertisements once their lifetime expires or
their URL Authentication Block "Timestamp" of expiration is past.

DAAdverts MUST include DA Stateless Boot Timestamp, in the same
format as the Authentication Block (see Section 9.2). The Timestamp
in the Authentication Block indicates the time at which all previous
registrations were lost (i.e., the last stateless reboot). The
Timestamp is set to 0 in a DAAdvert to notify UAs and SAs that the DA
is going down. DAs MUST NOT use equal or lesser Boot Timestamps to
previous ones, if they go down and restart without service
registration state. This would mislead SAs to not reregister with
the DA.

DAs which receive a multicast SrvRqst for the service type
"service:directory-agent" MUST silently discard it if the <scope-
list> is (a) not omitted and (b) does not include a scope they are
configured to use. Otherwise the DA MUST respond with a DAAdvert.

DAs MUST respond to AttrRqst and SrvTypeRqst messages (these are
OPTIONAL only for SAs, not DAs.)

12.2. Directory Agent Discovery

UAs can discover DAs using static configuration, DHCP options 78 and
79, or by multicasting (or broadcasting) Service Requests using the
convergence algorithm in Section 6.3.

See Section 6 regarding unsolicited DAAdverts. Section 12.2.2
describes how SAs may reduce the number of times they must reregister
with DAs in response to unsolicited DAAdverts.

DAs MUST send unsolicited DAAdverts once per CONFIG_DA_BEAT. An
unsolicited DAAdvert has an XID of 0. SAs MUST listen for DAAdverts,
passively, as described in Section 8.5. UAs MAY do this. If they do
not listen for unsolicited DAAdverts, however, they will not discover
DAs as they become available. UAs SHOULD, in this case, do periodic
active DA discovery, see Section 6.

A URL with the scheme "service:directory-agent" indicates the DA's
location as defined in Section 8.5. For example:
"service:directory-agent://foobawooba.org".

The following sections suggest timing algorithms which enhance the
scalability of SLP.

12.2.1. Active DA Discovery

After a UA or SA restarts, its initial DA discovery request SHOULD be
delayed for some random time uniformly distributed from 0 to
CONFIG_START_WAIT seconds.

The UA or SA sends the DA Discovery request using a SrvRqst, as
described in Section 8.1. DA Discovery requests MUST include a
Previous Responder List. SrvRqsts for Active DA Discovery SHOULD NOT
be sent more than once per CONFIG_DA_FIND seconds.

After discovering a new DA, a SA MUST wait a random time between 0
and CONFIG_REG_ACTIVE seconds before registering their services.

12.2.2. Passive DA Advertising

A DA MUST multicast (or broadcast) an unsolicited DAAdvert every
CONFIG_DA_BEAT seconds. CONFIG_DA_BEAT SHOULD be specified to
prevent DAAdverts from using more than 1% of the available bandwidth.

All UAs and SAs which receive the unsolicited DAAdvert SHOULD examine
its DA stateless Boot Timestamp. If it is set to 0, the DA is going
down and no further messages should be sent to it.

If a SA detects a DA it has never encountered (with a nonzero
timestamp,) the SA must register with it. SAs MUST examine the
DAAdvert's timestamp to determine if the DA has had a stateless
reboot since the SA last registered with it. If so it registers with
the DA. SAs MUST wait a random interval between 0 and
CONFIG_REG_PASSIVE before beginning DA registration.

12.3. Reliable Unicast to DAs and SAs

   If a DA or SA fails to respond to a unicast UDP message in
   CONFIG_RETRY seconds, the message should be retried. The wait
   interval for each subsequent retransmission MUST exponentially
   increase, doubling each time. If a DA or SA fails to respond after
   CONFIG_RETRY_MAX seconds, the sender should consider the receiver to
   have gone down. The UA should use a different DA. If no such DA
   responds, DA discovery should be used to find a new DA. If no DA is
   available, multicast requests to SAs are used.

12.4. DA Scope Configuration

   By default, DAs are configured with the "DEFAULT" scope.
   Administrators may add other configured scopes, in order to support
   UAs and SAs in non default scopes. The default configuration MUST
   NOT be removed from the DA unless:

    - There are other DAs which support the "DEFAULT" scope, or

    - All UAs and SAs have been configured with non-default scopes.

   Non-default scopes can be phased-in as the SLP deployment grows.
   Default scopes should be phased out only when the non-default scopes
   are universally configured.

   If a DA and SA are coresident on a host (quite possibly implemented
   by the same process), configuration of the host is considerably
   simplified if the SA supports only scopes also supported by the DA.
   That is, the SA SHOULD NOT advertise services in any scopes which are
   not supported by the coresident DA. This means that incoming requests
   can be answered by a single data store; the SA and DA registrations
   do not need to be kept separately.

12.5. DAs and Authentication Blocks

   DAs are not configured to sign service registrations or attribute
   lists. They simply cache services registered by Service Agents. DAs
   MUST NOT accept registrations including authentication blocks for SLP
   SPIs which it is not configured with, see Section 8.5.

   A DA protects registrations which are made with authentication blocks
   using SLP SPIs it is configured to use. If a service S is
   registered, a subsequent registration (which will replace the
   adertisement) or a deregistration (which will remove it) MUST include
   an Authentication Block with the corresponding SLP SPI, see Section
   8.3 and Section 10.6.

   Example:

   A DA is configured to be able to verify Authentication Blocks with
   SLP SPIs "X,Y", that is X and Y.

   An SA registers a service with an Authentication Block with SPI "Z".
   The DA stores the registration, but discards the Authentication
   Block. If a UA requests a service with an SLP SPI string "Z", the DA
   will respond with an AUTHENTICATION_UNKNOWN error.

   An SA registers a service S with Authentication Blocks including SLP
   SPIs "X" and "Y". If a UA requests a service with an SLP SPI string
   "X" the DA will be able to return S (if the service type, language,
   scope and predicate of the SrvRqst match S) The DA will also return
   the Authentication Block with SLP SPI set to "X". If the DA receives
   a subsequent SrvDeReg for S (which will remove the advertisement) or
   a subsequent SrvReg for S (which will replace it), the message must
   include two URL Authentication Blocks, one each for SPIs "X" and "Y".
   If either of these were absent, the DA would return an
   AUTHENTICATION_ABSENT error.

13. Protocol Timing Defaults

Interval name	Section	Default Value	Meaning
CONFIG_MC_MAX	6.3	15 seconds	Max time to wait for a complete multicast query response (all values.)
CONFIG_START_WAIT	12.2.1	3 seconds	Wait to perform DA discovery on reboot.
CONFIG_RETRY	12.3	2 seconds	Wait interval before initial retransmission of multicast or unicast requests.
CONFIG_RETRY_MAX	12.3	15 seconds	Give up on unicast request retransmission.
CONFIG_DA_BEAT	12.2.2	3 hours	DA Heartbeat, so that SAs passively detect new DAs.
CONFIG_DA_FIND	12.3	900 seconds	Minimum interval to wait before repeating Active DA discovery.
CONFIG_REG_PASSIVE	12.2	1-3 seconds	Wait to register services on passive DA discovery.
CONFIG_REG_ACTIVE	8.3	1-3 seconds	Wait to register services on active DA discovery.
CONFIG_CLOSE_CONN	6.2	5 minutes	DAs and SAs close idle connections.

14. Optional Configuration

    Broadcast Only
            Any SLP agent SHOULD be configurable to use broadcast
            only. See Sections 6.1 and 12.2.

    Predefined DA
            A UA or SA SHOULD be configurable to use a predefined DA.

    No DA Discovery
            The UA or SA SHOULD be configurable to ONLY use
            predefined and DHCP-configured DAs and perform no active
            or passive DA discovery.

    Multicast TTL
            The default multicast TTL is 255. Agents SHOULD be
            configurable to use other values. A lower value will
            focus the multicast convergence algorithm on smaller
            subnetworks, decreasing the number of responses and
            increases the performance of service location. This
            may result in UAs obtaining different results for the
            identical requests depending on where they are connected
            to the network.

    Timing Values
            Time values other than the default MAY be configurable.
            See Section 13.

    Scopes
            A UA MAY be configurable to support User Selectable
            scopes by omitting all predefined scopes. See
            Section 11.2. A UA or SA MUST be configurable to use
            specific scopes by default. Additionally, a UA or SA
            MUST be configurable to use specific scopes for requests
            for and registrations of specific service types. The
            scope or scopes of a DA MUST be configurable. The
            default value for a DA is to have the scope "DEFAULT" if
            not otherwise configured.

    DHCP Configuration
            DHCP options 78 and 79 may be used to configure SLP. If
            DA locations are configured using DHCP, these SHOULD
            be used in preference to DAs discovered actively or
            passively. One or more of the scopes configured using
            DHCP MUST be used in requests. The entire configured
            <scope-list> MUST be used in registration and DA
            configuration messages.

Service Template
        UAs and SAs MAY be configured by using Service Templates.
        Besides simplifying the specification of attribute
        values, this also allows them to enforce the inclusion
        of 'required' attributes in SrvRqst, SrvReg and SrvDeReg
        messages. DAs MAY be configured with templates to
        allow them to WARN UAs and SAs in these cases. See
        Section 10.4.

SLP SPI for service discovery
        Agents SHOULD be configurable to support SLP SPIs using
        the following parameters: BSD=2 (DSA with SHA-1) and
        a public key identified by the SLP SPI String. In
        the future, when a Public Key Infrastructure exists,
        SLP Agents may be able to obtain public keys and
        cryptographic parameters corresponding to the names used
        in SLP SPI Strings.

        Note that if the SLP SPI string chosen is identical
        to a scope string, it is effectively the same as a
        Protected Scope in SLPv1. Namely, every SA advertising
        in that scope would be configured with the same Private
        Key. Every DA and UA of that scope would be configured
        with the appropriate Public Key to verify signatures
        produced by those SAs. This is a convenient way to
        configure SLP deployments in the absence of a Public Key
        Infrastructure. Currently, it would be too difficult to
        manage the keying of UAs and DAs if each SA had its own
        key.

SLP SPI for Directory Agent discovery
        Agents SHOULD be configurable to support SLP SPIs as
        above, to be used when discovering DAs. This SPI SHOULD
        be sent in SrvRqsts to discover DAs and be used to verify
        multicast DAAdvert messages.

SA and DA Private Key
        SAs and DAs which can generate digital signatures require
        a Private Key and a corresponding SLP SPI indentifier
        to include in the Authentication Block. The SLP SPI
        identifies the Public Key to use to verify the digital
        signature in the Authentication Block.

15. IANA Considerations

   SLP includes four sets of identifiers which may be registered with
   IANA. The policies for these registrations (See [18]) are noted in
   each case.

The Block Structure Descriptor (BSD) identifies the format of the
Authenticator which follows. BSDs 0x8000-0x8FFF are for Private Use.

Further Block Structured Descriptor (BSD) values, from the range
0x0003-0x7FFF may be standardized in the future by submitting a
document which describes:

-     The data format of the Structured Authenticator block.

-     Which cryptographic algorithm to use (including a reference
      to a technical specification of the algorithm.)

-     The format of any keying material required for
      preconfiguring UAs, DAs and SAs. Also include any
      considerations regarding key distribution.

-     Security considerations to alert others to the strengths and
      weaknesses of the approach.

The IANA will assign Cryptographic BSD numbers on the basis of IETF
Consenus.

New function-IDs, in the range 12-255, may be standardized by the
method of IETF Consensus.

New SLP Extensions with types in the range 2-65535 may be registered
following review by a Designated Expert.

New error numbers in the range 15-65535 are assigned on the basis of
a Standards Action.

Protocol elements used with Service Location Protocol may also
require IANA registration actions. SLP is used in conjunction with
"service:" URLs and Service Templates [13]. These are standardized
by review of a Designated Expert and a mailing list (See [13].)

16. Internationalization Considerations

SLP messages support the use of multiple languages by providing a
Language Tag field in the common message header (see Section 8).

Services MAY be registered in multiple languages. This provides
attributes so that users with different language skills may select
services interactively.

Attribute tags are not translated. Attribute values may be
translated unless the Service Template [13] defines the attribute
values to be 'literal'.

A service which is registered in multiple languages may be queried in
multiple languages. The language of the SrvRqst or AttrRqst is used
to satisfy the request. If the requested language is not supported,
a LANGUAGE_NOT_SUPPORTED error is returned. SrvRply and AttrRply
messages are always in the same language of the request.

A DA or SA MAY be configured with translations of Service Templates
[13] for the same service type. This will allow the DA or SA to
translate a request (say in Italian) to the language of the service
advertisement (say in English) and then translate the reply back to
Italian. Similarly, a UA MAY use templates to translate outgoing
requests and incoming replies.

The dialect field in the Language Tag MAY be used: Requests which
can be fulfilled by matching a language and dialect will be preferred
to those which match only the language portion. Otherwise, dialects
have no effect on matching requests.

17. Security Considerations

SLP provides for authentication of service URLs and service
attributes. This provides UAs and DAs with knowledge of the
integrity of service URLs and attributes included in SLP messages.
The only systems which can generate digital signatures are those
which have been configured by administrators in advance. Agents
which verify signed data may assume it is 'trustworthy' inasmuch as
administrators have ensured the cryptographic keying of SAs and DAs
reflects 'trustworthiness.'

Service Location does not provide confidentiality. Because the
objective of this protocol is to advertise services to a community of
users, confidentiality might not generally be needed when this
protocol is used in non-sensitive environments. Specialized schemes
might be able to provide confidentiality, if needed in the future.
Sites requiring confidentiality should implement the IP Encapsulating
Security Payload (ESP) [3] to provide confidentiality for Service
Location messages.

If Agents are not configured to generate Authentication Blocks and
Agents are not configured to verify them, an adversary might easily
use this protocol to advertise services on servers controlled by the
adversary and thereby gain access to users' private information.
Further, an adversary using this protocol will find it much easier to
engage in selective denial of service attacks. Sites that are in
potentially hostile environments (e.g., are directly connected to the
Internet) should consider the advantages of distributing keys
associated with SLP SPIs prior to deploying the sensitive directory
agents or service agents.

SLP is useful as a bootstrap protocol. It may be used in
environments in which no preconfiguration is possible. In such
situations, a certain amount of "blind faith" is required: Without
any prior configuration it is impossible to use any of the security
mechanisms described above. SLP will make use of the mechanisms
provided by the Security Area of the IETF for key distribution as
they become available. At this point it would only be possible to
gain the benefits associated with the use of Authentication Blocks if
cryptographic information and SLP SPIs can be preconfigured with the
end systems before they use SLP.

SLPv2 enables a number of security policies with the mechanisms it
includes. A SLPv2 UA could, for instance, reject any SLP message
which did not carry an authentication block which it could verify.
This is not the only policy which is possible to implement.

A. Appendix: Changes to the Service Location Protocol from v1 to v2

   SLP version 2 (SLPv2) corrects race conditions present in SLPv1 [22].
   In addition, authentication has been reworked to provide more
   flexibility and protection (especially for DA Advertisements). SLPv2
   also changes the formats and definition of many flags and values and
   reduces the number of 'required features.' SLPv2 clarifies and
   changes the use of 'Scopes', eliminating support for 'unscoped
   directory agents' and 'unscoped requests'. SLPv2 uses LDAPv3
   compatible string encodings of attributes and search filters. Other
   changes (such as Language and Character set handling) adopt practices
   recommended by the Internet Engineering Steering Group.

   Effort has been made to make SLPv2 operate the same whether DAs are
   present or not. For this reason, a new message (the SAAdvert) has
   been added. This allows UAs to discover scope information in the
   absence of administrative configuration and DAs. This was not
   possible in SLPv1.

   SLPv2 is incompatible in some respects with SLPv1. If a DA which
   supports both SLPv1 and SLPv2 with the same scope is present,
   services advertised by SAs using either version of the protocol will
   be available to both SLPv1 and SLPv2 UAs. SLPv1 DAs SHOULD be phased
   out and replace with SLPv2 DAs which support both versions of the
   protocol.

   SLPv1 allows services to be advertised and requested without a scope.
   Further, DAs can be configured without a scope. This is incompatible
   with SLPv2 and presents scalability problems. To facilitate this
   forward migration, SLPv1 agents MUST use scopes for all registrations
   and requests. SLPv1 DAs MUST be configured with a scope list. This
   constitutes a revision of RFC 2165 [22].

B. Appendix: Service Discovery by Type: Minimal SLPv2 Features

   Service Agents may advertise services without attributes. This will
   enable only discovery of services by type. Service types discovered
   this way will have a Service Template [13] defined which specifies
   explicitly that no attributes are associated with the service
   advertisement. Service types associated with Service Templates which
   specify attributes MUST NOT be advertised by SAs which do not support
   attributes.

   While discovery of service by service type is a subset of the
   features possible using SLPv2 this form of discovery is consistent
   with the current generation of products that allow simple browsing of
   all services in a 'zone' or 'workgroup' by type. In some cases,
   attribute discovery, security and feature negotiation is handled by

   application layer protocols - all that is required is the basic
   discovery of services that support a certain service.

   UAs requesting only service of that service type would only need to
   support service type and scope fields of the Service Request. UAs
   would still perform DA discovery and unicast SLPv2 SrvRqst messages
   to DAs in their scope once they were discovered instead of
   multicasting them.

   SAs would also perform DA discovery and use a SLPv2 SrvReg to
   register all their advertised services with SLPv2 DAs in their scope.
   These advertisements would needless to say contain no attribute
   string.

   These minimal SAs could ignore the Language Tag in requests since
   SrvRqst messages would contain no attributes, hence no strings would
   be internationalized. Further, any non-null predicate string would
   fail to match a service advertisement with no attributes, so these
   SAs would not have to parse and interpret search filters. Overflow
   will never occur in SrvRqst, SrvRply or SrvReg messages so TCP
   message handling would not have to be implemented. Finally, all
   AttrRqst messages could be dropped by the SA, since no attributes are
   supported.

C. Appendix: DAAdverts with arbitrary URLs

   Using Active DA Discovery, a SrvRqst with its service type field set
   to "service:directory-agent". DAs will respond with a DAAdvert
   containing a URL with the "service:directory-agent:" scheme. This is
   the same DAAdvert that such a DA would multicast in unsolicited DA
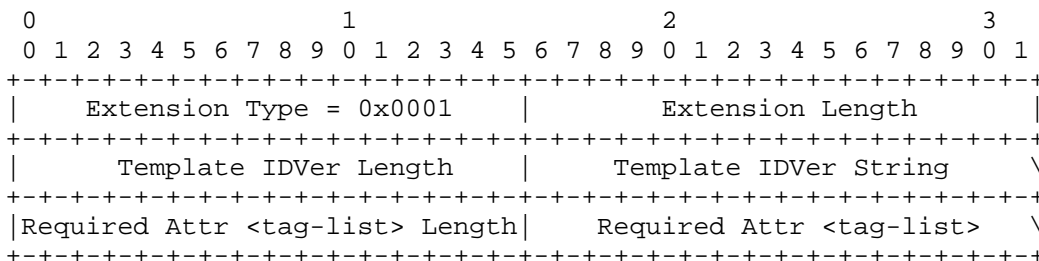   advertisements.

   A UA or SA which receives an unsolicited DAAdvert MUST examine the
   URL to determine if it has a recognized scheme. If the UA or SA does
   not recognize the DAAdvert's URL scheme, the DAAdvert is silently
   discarded. This document specifies only how to use URLs with the
   "service:directory-agent:" scheme.

   This provides the possibility for forward compatibility with future
   versions of SLP and enables other services to advertise their ability
   to serve as a clearinghouse for service location information.

   For example, if LDAPv3 [15] is used for service registration and
   discovery by a set of end systems, they could interpret a LDAP URL
   [16] to passively discover the LDAP server to use for this purpose.
   This document does not specify how this is done: SLPv2 agents
   without further support would simply discard this DAAdvert.

D. Appendix: SLP Protocol Extensions

D.1. Required Attribute Missing Option

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Extension Type = 0x0001   |         Extension Length      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Template IDVer Length     |     Template IDVer String     \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Required Attr <tag-list> Length|     Required Attr <tag-list>   \
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Required attributes and the format of the IDVer string are defined by
   [13].

   If a SA or DA receives a SrvRqst or a SrvReg which fails to include a
   Required Attribute for the requested Service Type (according to the
   Service Template), it MAY return the Required Attribute Extension in
   addition to the reply corresponding to the message. The sender
   SHOULD reissue the message with a search filter including the
   attributes listed in the returned Required Attribute Extension.
   Similarly, the Required Attribute Extension may be returned in
   response to a SrvDereg message that contains a required attribute
   tag.

   The Template IDVer String is the name and version number string of
   the Service Template which defines the given attribute as required.
   It SHOULD be included, but can be omitted if a given SA or DA has
   been individually configured to have 'required attributes.'

   The Required Attribute <tag-list> MUST NOT include wild cards.

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   Sun Microsystems have contributed significantly to make this a much
   clearer and more consistent document.

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