Adding the "find" Operation to the dtn: URI Scheme
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Abstract

This document discusses the addition of a new operation to the proposed dtn: URI (Uniform Resource Identifier) scheme. The new
"find" operation would provide support for DTN (Delay- and Disruption-Tolerant Network) anycast services.

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1. Introduction

This document describes the addition of an extra operation to the proposed dtn: URI (Uniform Resource Identifier) scheme documented in [I-D.irtf-dtnrg-dtn-uri-scheme].

The purpose of the "find" operation is to allow DTN nodes to access services that they do not or cannot support through exchange of DTN bundles. In the spirit of DTN operation, nodes expect to be able to operate independently and may not know exactly where such a service is implemented, but has a reasonable expectation that such a service is provided by another node accessible using DTN.

Apart from the usual concept of services such as requesting printing of a bundle payload or accessing a web proxy, the "find" operation can also be used to find gateways onto remote networks that use other forms of addressing than the Endpoint IDs (EIDs) normally used to identify DTN nodes and to route bundles outside the current "association" where the bundles was created.

When a bundle arrives at a DTN node that implements the service indicated, the action taken depends on the service requested. In the case of gateway services, the bundle will simply be forwarded to the bundle agent on the addressed node. For other services, the bundle’s payload will be passed to the service agent on the node together with any parameters derived from the service specification in the destination URI.

In order for the "find" operation to work satisfactorily, the routing service, whether static or dynamic, would need to collect and propagate information about the "services" offered by the nodes to which it was able to route bundles. With the help of this information, the DTN routing system could offer a form of "anycast" service that delivered appropriately addressed bundles to one or more nodes that offer the services requested in the "find" addressing format. Especially in the dynamic case, service announcements will need to be propagated in the DTN network. The mechanism to be used to provide these announcements requires further study. Where services are provided by gateway nodes at the edge of the Internet static configuration in some DTN nodes may be sufficient.

2. Requirements Notation

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].
3. Changes to "dtn" Scheme Syntax and Rules

3.1. Syntax

The general syntax of a dtn URI as defined in [I-D.irtf-dtnrg-dtn-uri-scheme] is unchanged except for the addition of "find" to opname. The revised ABNF [RFC5234] is:

\[
dtnURI = "dtn:" ("none" / nontrivialSSP)
\]

where:

\[
nontrivialSSP = dtnURIelt *(!" dtnURIelt)
\]

\[
dtnURIelt = [opname] ":" URI ; URI as defined in RFC 3986 [*]
\]

\[
opname = "push" / "pop" / "next" / "flood" / "exec"/ "find"
\]

3.2. Changes to Resolution of DTN Endpoint IDs

Section 2.2 of [I-D.irtf-dtnrg-dtn-uri-scheme] contains definitions of the various operations listed under "opname" in the ABNF. For the "find" operation the following definition should be added after the definition of "exec":

\[
find: When the operation name is "find", the bundle agent SHOULD use information accumulated by the DTN routing system in use to forward the bundle towards one or more nodes that are able to deliver the requested service or would be better able to forward the bundle towards such a node. However, the node MAY determine that it is able to deliver the bundle locally to an agent that can provide the requested service: in this case the operation is equivalent to the "pop" operation. If the node is unable to determine a suitable target it MAY drop the bundle.
\]

When the bundle is delivered to a node that provides the specified service then, depending on the service specified, the bundle is either forwarded to the bundle agent on a node using an alternative addressing scheme or passed to the service agent for the service on the current node.

4. Examples

Several examples of the use of the "find" operation are presented split between conventional services delivered by a local service agent, such as a SMTP mail server, and services that provide access to networks using alternative addressing schemes, such as IPv4.
4.1. Services Delivered by Local Service Agents

In these cases the bundle is passed to a service agent that will generally be expected to decapsulate the bundle and use the payload in combination with any parameters passed in the service description in the dtn: URI to deliver the requested service.

4.1.1. dtn:find:mailto:another@example.org,second@example.org

Citing this EID as the destination of a bundle causes the bundle to be delivered to a node that provides an (outgoing) email server that can forward the payload of the bundle as an email to the specified address(es) in the mailto URI or local account(s) to which the email can be delivered. In this case the bundle payload is expected to contain one or more emails in [RFC2822] format.

4.1.2. dtn:find:service:printer?printer-color-supported=true

Citing this EID as the destination of a bundle causes the bundle to be delivered to a node that provides a printing service. The specified attribute requests that a color capable printer be used to print the payload carried in the bundle. This example uses the service: URI template "printer.2.0.en" <http://www.iana.org/assignments/svrloc-templates/printer.2.0.en> that conforms to the specification in [RFC2609].

4.1.3. dtn:find:service:fax?destination=+4416324960123

Citing this EID as the destination of a bundle is intended to cause the bundle to be delivered to a node that provides a telephone facsimile (fax) service. Note that this would require the definition of a new service: URI template for a fax delivery service which provided the "destination" attribute that would be the telephone number called. The payload of the bundle would be sent as a fax to the specified destination.


Citing this EID as the destination of a bundle is intended to cause the bundle to be delivered to a node that provides a (caching) web proxy service. As with the previous example, this proposes the use of a yet-to-be created service: URI template for a web proxy service that would access the specified URI using the HTTP protocol. Typically the HTML in the page returned from the initial request would require additional accesses to build up the entire displayed page (c.f., the GNU "wget" tool that returns content from web servers <http://www.gnu.org/software/wget/>). The "depth" parameter controls
the depth of recursion of such accesses. The suite of returned HTML
documents would be combined into a single bundle that would be
returned to the requestor. The complete service would provide
additional parameters to control the behavior of the service and
possibly cause repeated operation on a timed basis.

4.1.5.  dtn:find:service:htpproxy:http:?telephone+number+example,
&width=5,&depth=3

This example is similar to the previous example in Section 4.1.4,
except that the intention is to have the service access a suitable
web search engine (to be chosen by the service provider) to look up
information according to the query (in this case information about
example numbers to be used when describing a telephone service) with
parameters that control the number of returned results (&width
parameter) to be examined in more detail by accessing the returned
URIs recursively to the value of the &depth parameter. Again the
complete set of results would be returned as a single bundle and
additional parameters could be defined.

4.2. Services Delivered by Forwarding the Bundle Using Alternative
Addressing

The examples in this section show how the "find" operation could be
used to deliver bundles to nodes that implement a bundle agent but
that are also identified by another form of identifier or locator
than a "universal" dtn: URI. The means used to deliver the bundle
will be dependent on the network technology associated with the
addressing format used.

In all cases the bundle is forwarded as a bundle rather than being
decapsulated. At the destination additional parts of the URI will be
used to demultiplex the bundle to the appropriate application to
which it is directed as with conventional EID addressing.

4.2.1.  dtn:find:intent#
    role(?E,coffee),location(?E,Loc),within(100,(1,3),Loc)

The concept of intentional naming is described in
[I-D.pbasu-dtnrg-naming]. An example of the naming scheme used with
the GRAIN (Gradient-Based Algorithm for Intentional Naming) algorithm
to locate nodes that satisfy the intentional naming specification is
given at the end of Section 5.5 of the Intentional Naming draft. The
mechanism needs additional support from the dtn: URI scheme to be
usable in a DTN network. We suggest that the "find" operation could
be used in the way illustrated in this example to direct bundles to
appropriate nodes using an intentional naming scheme. We also note
that it would also be possible to specify the intentional naming
mechanism through a service: URI service template which would allow it to be used in the wider Internet instead of defined a separate "intent" URI scheme restricted to DTN.

4.2.2.  dtn:find:assoc:wanderer3.basel.example.dtn

The basic naming scheme for DTN nodes (EIDs) anticipates that names would be globally valid. In order to improve the scaling of DTN networks, the concept of "associations" has been discussed. This usage of the "find" operation would allow a node to be located via a name which was applicable only within a given association. Routing would endeavour to locate a node which was a member of the association or find a suitable gateway that might have such information.

4.2.3.  dtn:find:dns:foo.bar.example.net

In this case the bundle is destined for a node in the IP-addressed Internet that has an entry in the DNS (Domain Name System), which can be looked up to provide an IP address where the bundle can be delivered. The bundle agent "service" could either be accessed through a well-known TCP or UDP port or looked up in a DNS service record. The bundle would be delivered using the TCP or (possibly) the UDP convergence layer. The bundle agent can use IPv4 or IPv6 according to what addresses are provided by DNS, the capabilities of the local node and a policy choice if both are available.

4.2.4.  dtn:find:ipv4:192.0.2.27

This example is equivalent to the previous example except that "find" needs to locate a gateway that provides IPv4 connectivity onto the Internet. The forward DNS lookup is not required but it may be necessary to perform a reverse lookup to check that the bundle agent service is available and determine the protocol and port to use.

4.2.5.  dtn:find:ipv6:[2001:db8::27:ef12]

A similar example to Section 4.2.4 but using an IPv6 address. The "find" operation needs to locate a gateway providing IPv6 connectivity onto the Internet.

5.  Security Considerations

The addition of the "find" operation does not appear to introduce any extra security issues beyond the considerable challenges already facing DTN security.
6. IANA Considerations

It is intended that the "find" operation will be folded into the dtn: URI scheme being defined in [I-D.irtf-dtnrg-dtn-uri-scheme] which will be registered in the URI registry defined in [RFC4395].

The "find" operation expects to use URIs following the service: URI scheme ([RFC2609]) and possibly other existing schemes. It may require the definition of new service templates according to the service: URI definition.

7. Acknowledgments

8. References

8.1. Normative References

[I-D.irtf-dtnrg-dtn-uri-scheme]


8.2. Informative References

[I-D.pbasu-dtnrg-naming]


Authors’ Addresses

Elwyn B. Davies
Folly Consulting
Soham, Cambs
UK

Phone: +44 7889 488 335
Email: elwynd@dial.pipex.com

Avri Doria
LTU
Lulea, 971 87
Sweden

Phone: +1 401 663 5024
Email: avri@acm.org