

Network Working Group
Request for Comments: 4918
Obsoletes: 2518
Category: Standards Track

L. Dusseault, Ed.
CommerceNet
June 2007

HTTP Extensions for Web Distributed Authoring and Versioning (WebDAV)

Status of This Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

Copyright Notice

Copyright (C) The IETF Trust (2007).

Abstract

Web Distributed Authoring and Versioning (WebDAV) consists of a set of methods, headers, and content-types ancillary to HTTP/1.1 for the management of resource properties, creation and management of resource collections, URL namespace manipulation, and resource locking (collision avoidance).

RFC 2518 was published in February 1999, and this specification obsoletes RFC 2518 with minor revisions mostly due to interoperability experience.

Table of Contents

1. Introduction	7
2. Notational Conventions	8
3. Terminology	8
4. Data Model for Resource Properties	10
4.1. The Resource Property Model	10
4.2. Properties and HTTP Headers	10
4.3. Property Values	10
4.3.1. Example - Property with Mixed Content	12
4.4. Property Names	14
4.5. Source Resources and Output Resources	14
5. Collections of Web Resources	14
5.1. HTTP URL Namespace Model	15
5.2. Collection Resources	15
6. Locking	17
6.1. Lock Model	18
6.2. Exclusive vs. Shared Locks	19
6.3. Required Support	20
6.4. Lock Creator and Privileges	20
6.5. Lock Tokens	21
6.6. Lock Timeout	21
6.7. Lock Capability Discovery	22
6.8. Active Lock Discovery	22
7. Write Lock	23
7.1. Write Locks and Properties	24
7.2. Avoiding Lost Updates	24
7.3. Write Locks and Unmapped URLs	25
7.4. Write Locks and Collections	26
7.5. Write Locks and the If Request Header	28
7.5.1. Example - Write Lock and COPY	28
7.5.2. Example - Deleting a Member of a Locked Collection	29
7.6. Write Locks and COPY/MOVE	30
7.7. Refreshing Write Locks	30
8. General Request and Response Handling	31
8.1. Precedence in Error Handling	31
8.2. Use of XML	31
8.3. URL Handling	32
8.3.1. Example - Correct URL Handling	32
8.4. Required Bodies in Requests	33
8.5. HTTP Headers for Use in WebDAV	33
8.6. ETag	33
8.7. Including Error Response Bodies	34
8.8. Impact of Namespace Operations on Cache Validators	34
9. HTTP Methods for Distributed Authoring	35
9.1. PROPFIND Method	35
9.1.1. PROPFIND Status Codes	37

9.1.2.	Status Codes for Use in 'propstat' Element	37
9.1.3.	Example - Retrieving Named Properties	38
9.1.4.	Example - Using 'propname' to Retrieve All Property Names	39
9.1.5.	Example - Using So-called 'allprop'	41
9.1.6.	Example - Using 'allprop' with 'include'	43
9.2.	PROPPATCH Method	44
9.2.1.	Status Codes for Use in 'propstat' Element	44
9.2.2.	Example - PROPPATCH	45
9.3.	MKCOL Method	46
9.3.1.	MKCOL Status Codes	47
9.3.2.	Example - MKCOL	47
9.4.	GET, HEAD for Collections	48
9.5.	POST for Collections	48
9.6.	DELETE Requirements	48
9.6.1.	DELETE for Collections	49
9.6.2.	Example - DELETE	49
9.7.	PUT Requirements	50
9.7.1.	PUT for Non-Collection Resources	50
9.7.2.	PUT for Collections	51
9.8.	COPY Method	51
9.8.1.	COPY for Non-collection Resources	51
9.8.2.	COPY for Properties	52
9.8.3.	COPY for Collections	52
9.8.4.	COPY and Overwriting Destination Resources	53
9.8.5.	Status Codes	54
9.8.6.	Example - COPY with Overwrite	55
9.8.7.	Example - COPY with No Overwrite	55
9.8.8.	Example - COPY of a Collection	56
9.9.	MOVE Method	56
9.9.1.	MOVE for Properties	57
9.9.2.	MOVE for Collections	57
9.9.3.	MOVE and the Overwrite Header	58
9.9.4.	Status Codes	59
9.9.5.	Example - MOVE of a Non-Collection	60
9.9.6.	Example - MOVE of a Collection	60
9.10.	LOCK Method	61
9.10.1.	Creating a Lock on an Existing Resource	61
9.10.2.	Refreshing Locks	62
9.10.3.	Depth and Locking	62
9.10.4.	Locking Unmapped URLs	63
9.10.5.	Lock Compatibility Table	63
9.10.6.	LOCK Responses	63
9.10.7.	Example - Simple Lock Request	64
9.10.8.	Example - Refreshing a Write Lock	65
9.10.9.	Example - Multi-Resource Lock Request	66
9.11.	UNLOCK Method	68
9.11.1.	Status Codes	68

9.11.2. Example - UNLOCK	69
10. HTTP Headers for Distributed Authoring	69
10.1. DAV Header	69
10.2. Depth Header	70
10.3. Destination Header	71
10.4. If Header	72
10.4.1. Purpose	72
10.4.2. Syntax	72
10.4.3. List Evaluation	73
10.4.4. Matching State Tokens and ETags	74
10.4.5. If Header and Non-DAV-Aware Proxies	74
10.4.6. Example - No-tag Production	75
10.4.7. Example - Using "Not" with No-tag Production	75
10.4.8. Example - Causing a Condition to Always Evaluate to True	75
10.4.9. Example - Tagged List If Header in COPY	76
10.4.10. Example - Matching Lock Tokens with Collection Locks	76
10.4.11. Example - Matching ETags on Unmapped URLs	76
10.5. Lock-Token Header	77
10.6. Overwrite Header	77
10.7. Timeout Request Header	78
11. Status Code Extensions to HTTP/1.1	78
11.1. 207 Multi-Status	78
11.2. 422 Unprocessable Entity	78
11.3. 423 Locked	78
11.4. 424 Failed Dependency	79
11.5. 507 Insufficient Storage	79
12. Use of HTTP Status Codes	79
12.1. 412 Precondition Failed	79
12.2. 414 Request-URI Too Long	79
13. Multi-Status Response	80
13.1. Response Headers	80
13.2. Handling Redirected Child Resources	81
13.3. Internal Status Codes	81
14. XML Element Definitions	81
14.1. activelock XML Element	81
14.2. allprop XML Element	82
14.3. collection XML Element	82
14.4. depth XML Element	82
14.5. error XML Element	82
14.6. exclusive XML Element	83
14.7. href XML Element	83
14.8. include XML Element	83
14.9. location XML Element	83
14.10. lockentry XML Element	84
14.11. lockinfo XML Element	84
14.12. lockroot XML Element	84

14.13.	lockscope XML Element	84
14.14.	locktoken XML Element	85
14.15.	locktype XML Element	85
14.16.	multistatus XML Element	85
14.17.	owner XML Element	85
14.18.	prop XML Element	86
14.19.	propertyupdate XML Element	86
14.20.	propfind XML Element	86
14.21.	propname XML Element	87
14.22.	propstat XML Element	87
14.23.	remove XML Element	87
14.24.	response XML Element	88
14.25.	responsedescription XML Element	88
14.26.	set XML Element	88
14.27.	shared XML Element	89
14.28.	status XML Element	89
14.29.	timeout XML Element	89
14.30.	write XML Element	89
15.	DAV Properties	90
16.	Precondition/Postcondition XML Elements	98
17.	XML Extensibility in DAV	101
18.	DAV Compliance Classes	103
18.1.	Class 1	103
18.2.	Class 2	103
18.3.	Class 3	103
19.	Internationalization Considerations	104
20.	Security Considerations	105
20.1.	Authentication of Clients	105
20.2.	Denial of Service	106
20.3.	Security through Obscurity	106
20.4.	Privacy Issues Connected to Locks	106
20.5.	Privacy Issues Connected to Properties	107
20.6.	Implications of XML Entities	107
20.7.	Risks Connected with Lock Tokens	108
20.8.	Hosting Malicious Content	108
21.	IANA Considerations	109
21.1.	New URI Schemes	109
21.2.	XML Namespaces	109
21.3.	Message Header Fields	109
21.3.1.	DAV	109
21.3.2.	Depth	110
21.3.3.	Destination	110
21.3.4.	If	110
21.3.5.	Lock-Token	110
21.3.6.	Overwrite	111
21.3.7.	Timeout	111
21.4.	HTTP Status Codes	111
22.	Acknowledgements	112

23. Contributors to This Specification	113
24. Authors of RFC 2518	113
25. References	114
25.1. Normative References.....	114
25.2. Informative References	115
Appendix A. Notes on Processing XML Elements	117
A.1. Notes on Empty XML Elements	117
A.2. Notes on Illegal XML Processing	117
A.3. Example - XML Syntax Error	117
A.4. Example - Unexpected XML Element	118
Appendix B. Notes on HTTP Client Compatibility	119
Appendix C. The 'opaquelocktoken' Scheme and URIs	120
Appendix D. Lock-null Resources	120
D.1. Guidance for Clients Using LOCK to Create Resources	121
Appendix E. Guidance for Clients Desiring to Authenticate	121
Appendix F. Summary of Changes from RFC 2518	123
F.1. Changes for Both Client and Server Implementations	123
F.2. Changes for Server Implementations	125
F.3. Other Changes	126

1. Introduction

This document describes an extension to the HTTP/1.1 protocol that allows clients to perform remote Web content authoring operations. This extension provides a coherent set of methods, headers, request entity body formats, and response entity body formats that provide operations for:

Properties: The ability to create, remove, and query information about Web pages, such as their authors, creation dates, etc.

Collections: The ability to create sets of documents and to retrieve a hierarchical membership listing (like a directory listing in a file system).

Locking: The ability to keep more than one person from working on a document at the same time. This prevents the "lost update problem", in which modifications are lost as first one author, then another, writes changes without merging the other author's changes.

Namespace Operations: The ability to instruct the server to copy and move Web resources, operations that change the mapping from URLs to resources.

Requirements and rationale for these operations are described in a companion document, "Requirements for a Distributed Authoring and Versioning Protocol for the World Wide Web" [RFC2291].

This document does not specify the versioning operations suggested by [RFC2291]. That work was done in a separate document, "Versioning Extensions to WebDAV" [RFC3253].

The sections below provide a detailed introduction to various WebDAV abstractions: resource properties (Section 4), collections of resources (Section 5), locks (Section 6) in general, and write locks (Section 7) specifically.

These abstractions are manipulated by the WebDAV-specific HTTP methods (Section 9) and the extra HTTP headers (Section 10) used with WebDAV methods. General considerations for handling HTTP requests and responses in WebDAV are found in Section 8.

While the status codes provided by HTTP/1.1 are sufficient to describe most error conditions encountered by WebDAV methods, there are some errors that do not fall neatly into the existing categories. This specification defines extra status codes developed for WebDAV methods (Section 11) and describes existing HTTP status codes (Section 12) as used in WebDAV. Since some WebDAV methods may

operate over many resources, the Multi-Status response (Section 13) has been introduced to return status information for multiple resources. Finally, this version of WebDAV introduces precondition and postcondition (Section 16) XML elements in error response bodies.

WebDAV uses XML ([REC-XML]) for property names and some values, and also uses XML to marshal complicated requests and responses. This specification contains DTD and text definitions of all properties (Section 15) and all other XML elements (Section 14) used in marshalling. WebDAV includes a few special rules on extending WebDAV XML marshalling in backwards-compatible ways (Section 17).

Finishing off the specification are sections on what it means for a resource to be compliant with this specification (Section 18), on internationalization support (Section 19), and on security (Section 20).

2. Notational Conventions

Since this document describes a set of extensions to the HTTP/1.1 protocol, the augmented BNF used herein to describe protocol elements is exactly the same as described in Section 2.1 of [RFC2616], including the rules about implied linear whitespace. Since this augmented BNF uses the basic production rules provided in Section 2.2 of [RFC2616], these rules apply to this document as well. Note this is not the standard BNF syntax used in other RFCs.

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].

Note that in natural language, a property like the "creationdate" property in the "DAV:" XML namespace is sometimes referred to as "DAV:creationdate" for brevity.

3. Terminology

URI/URL - A Uniform Resource Identifier and Uniform Resource Locator, respectively. These terms (and the distinction between them) are defined in [RFC3986].

URI/URL Mapping - A relation between an absolute URI and a resource. Since a resource can represent items that are not network retrievable, as well as those that are, it is possible for a resource to have zero, one, or many URI mappings. Mapping a resource to an "http" scheme URI makes it possible to submit HTTP protocol requests to the resource using the URI.

Path Segment - Informally, the characters found between slashes ("/") in a URI. Formally, as defined in Section 3.3 of [RFC3986].

Collection - Informally, a resource that also acts as a container of references to child resources. Formally, a resource that contains a set of mappings between path segments and resources and meets the requirements defined in Section 5.

Internal Member (of a Collection) - Informally, a child resource of a collection. Formally, a resource referenced by a path segment mapping contained in the collection.

Internal Member URL (of a Collection) - A URL of an internal member, consisting of the URL of the collection (including trailing slash) plus the path segment identifying the internal member.

Member (of a Collection) - Informally, a "descendant" of a collection. Formally, an internal member of the collection, or, recursively, a member of an internal member.

Member URL (of a Collection) - A URL that is either an internal member URL of the collection itself, or is an internal member URL of a member of that collection.

Property - A name/value pair that contains descriptive information about a resource.

Live Property - A property whose semantics and syntax are enforced by the server. For example, the live property DAV:getcontentlength has its value, the length of the entity returned by a GET request, automatically calculated by the server.

Dead Property - A property whose semantics and syntax are not enforced by the server. The server only records the value of a dead property; the client is responsible for maintaining the consistency of the syntax and semantics of a dead property.

Principal - A distinct human or computational actor that initiates access to network resources.

State Token - A URI that represents a state of a resource. Lock tokens are the only state tokens defined in this specification.

4. Data Model for Resource Properties

4.1. The Resource Property Model

Properties are pieces of data that describe the state of a resource. Properties are data about data.

Properties are used in distributed authoring environments to provide for efficient discovery and management of resources. For example, a 'subject' property might allow for the indexing of all resources by their subject, and an 'author' property might allow for the discovery of what authors have written which documents.

The DAV property model consists of name/value pairs. The name of a property identifies the property's syntax and semantics, and provides an address by which to refer to its syntax and semantics.

There are two categories of properties: "live" and "dead". A live property has its syntax and semantics enforced by the server. Live properties include cases where a) the value of a property is protected and maintained by the server, and b) the value of the property is maintained by the client, but the server performs syntax checking on submitted values. All instances of a given live property MUST comply with the definition associated with that property name. A dead property has its syntax and semantics enforced by the client; the server merely records the value of the property verbatim.

4.2. Properties and HTTP Headers

Properties already exist, in a limited sense, in HTTP message headers. However, in distributed authoring environments, a relatively large number of properties are needed to describe the state of a resource, and setting/returning them all through HTTP headers is inefficient. Thus, a mechanism is needed that allows a principal to identify a set of properties in which the principal is interested and to set or retrieve just those properties.

4.3. Property Values

The value of a property is always a (well-formed) XML fragment.

XML has been chosen because it is a flexible, self-describing, structured data format that supports rich schema definitions, and because of its support for multiple character sets. XML's self-describing nature allows any property's value to be extended by adding elements. Clients will not break when they encounter extensions because they will still have the data specified in the original schema and MUST ignore elements they do not understand.

XML's support for multiple character sets allows any human-readable property to be encoded and read in a character set familiar to the user. XML's support for multiple human languages, using the "xml:lang" attribute, handles cases where the same character set is employed by multiple human languages. Note that xml:lang scope is recursive, so an xml:lang attribute on any element containing a property name element applies to the property value unless it has been overridden by a more locally scoped attribute. Note that a property only has one value, in one language (or language MAY be left undefined); a property does not have multiple values in different languages or a single value in multiple languages.

A property is always represented with an XML element consisting of the property name, called the "property name element". The simplest example is an empty property, which is different from a property that does not exist:

```
<R:title xmlns:R="http://www.example.com/ns/"></R:title>
```

The value of the property appears inside the property name element. The value may be any kind of well-formed XML content, including both text-only and mixed content. Servers MUST preserve the following XML Information Items (using the terminology from [REC-XML-INFOSET]) in storage and transmission of dead properties:

For the property name Element Information Item itself:

[namespace name]

[local name]

[attributes] named "xml:lang" or any such attribute in scope

[children] of type element or character

On all Element Information Items in the property value:

[namespace name]

[local name]

[attributes]

[children] of type element or character

On Attribute Information Items in the property value:

[namespace name]

[local name]

[normalized value]

On Character Information Items in the property value:

[character code]

Since prefixes are used in some XML vocabularies (XPath and XML Schema, for example), servers SHOULD preserve, for any Information Item in the value:

[prefix]

XML Infoset attributes not listed above MAY be preserved by the server, but clients MUST NOT rely on them being preserved. The above rules would also apply by default to live properties, unless defined otherwise.

Servers MUST ignore the XML attribute `xml:space` if present and never use it to change whitespace handling. Whitespace in property values is significant.

4.3.1. Example - Property with Mixed Content

Consider a dead property 'author' created by the client as follows:

```
<D:prop xml:lang="en" xmlns:D="DAV:">
  <x:author xmlns:x='http://example.com/ns'>
    <x:name>Jane Doe</x:name>
    <!-- Jane's contact info -->
    <x:uri type='email'
      added='2005-11-26'>mailto:jane.doe@example.com</x:uri>
    <x:uri type='web'
      added='2005-11-27'>http://www.example.com</x:uri>
    <x:notes xmlns:h='http://www.w3.org/1999/xhtml'>
      Jane has been working way <h:em>too</h:em> long on the
      long-awaited revision of <![CDATA[<RFC2518>]]>.
    </x:notes>
  </x:author>
</D:prop>
```

When this property is requested, a server might return:

```
<D:prop xmlns:D='DAV:'><author
  xml:lang='en'
  xmlns:x='http://example.com/ns'
  xmlns='http://example.com/ns'
  xmlns:h='http://www.w3.org/1999/xhtml'>
  <x:name>Jane Doe</x:name>
  <x:uri   added="2005-11-26" type="email"
    >mailto:jane.doe@example.com</x:uri>
  <x:uri   added="2005-11-27" type="web"
    >http://www.example.com</x:uri>
  <x:notes>
    Jane has been working way <h:em>too</h:em> long on the
    long-awaited revision of &lt;RFC2518&gt;.
  </x:notes>
</author>
</D:prop>
```

Note in this example:

- o The [prefix] for the property name itself was not preserved, being non-significant, whereas all other [prefix] values have been preserved,
- o attribute values have been rewritten with double quotes instead of single quotes (quoting style is not significant), and attribute order has not been preserved,
- o the xml:lang attribute has been returned on the property name element itself (it was in scope when the property was set, but the exact position in the response is not considered significant as long as it is in scope),
- o whitespace between tags has been preserved everywhere (whitespace between attributes not so),
- o CDATA encapsulation was replaced with character escaping (the reverse would also be legal),
- o the comment item was stripped (as would have been a processing instruction item).

Implementation note: there are cases such as editing scenarios where clients may require that XML content is preserved character by character (such as attribute ordering or quoting style). In this case, clients should consider using a text-only property value by escaping all characters that have a special meaning in XML parsing.

4.4. Property Names

A property name is a universally unique identifier that is associated with a schema that provides information about the syntax and semantics of the property.

Because a property's name is universally unique, clients can depend upon consistent behavior for a particular property across multiple resources, on the same and across different servers, so long as that property is "live" on the resources in question, and the implementation of the live property is faithful to its definition.

The XML namespace mechanism, which is based on URIs ([RFC3986]), is used to name properties because it prevents namespace collisions and provides for varying degrees of administrative control.

The property namespace is flat; that is, no hierarchy of properties is explicitly recognized. Thus, if a property A and a property A/B exist on a resource, there is no recognition of any relationship between the two properties. It is expected that a separate specification will eventually be produced that will address issues relating to hierarchical properties.

Finally, it is not possible to define the same property twice on a single resource, as this would cause a collision in the resource's property namespace.

4.5. Source Resources and Output Resources

Some HTTP resources are dynamically generated by the server. For these resources, there presumably exists source code somewhere governing how that resource is generated. The relationship of source files to output HTTP resources may be one to one, one to many, many to one, or many to many. There is no mechanism in HTTP to determine whether a resource is even dynamic, let alone where its source files exist or how to author them. Although this problem would usefully be solved, interoperable WebDAV implementations have been widely deployed without actually solving this problem, by dealing only with static resources. Thus, the source vs. output problem is not solved in this specification and has been deferred to a separate document.

5. Collections of Web Resources

This section provides a description of a type of Web resource, the collection, and discusses its interactions with the HTTP URL namespace and with HTTP methods. The purpose of a collection resource is to model collection-like objects (e.g., file system directories) within a server's namespace.

All DAV-compliant resources MUST support the HTTP URL namespace model specified herein.

5.1. HTTP URL Namespace Model

The HTTP URL namespace is a hierarchical namespace where the hierarchy is delimited with the "/" character.

An HTTP URL namespace is said to be consistent if it meets the following conditions: for every URL in the HTTP hierarchy there exists a collection that contains that URL as an internal member URL. The root, or top-level collection of the namespace under consideration, is exempt from the previous rule. The top-level collection of the namespace under consideration is not necessarily the collection identified by the absolute path '/' -- it may be identified by one or more path segments (e.g., /servlets/webdav/...)

Neither HTTP/1.1 nor WebDAV requires that the entire HTTP URL namespace be consistent -- a WebDAV-compatible resource may not have a parent collection. However, certain WebDAV methods are prohibited from producing results that cause namespace inconsistencies.

As is implicit in [RFC2616] and [RFC3986], any resource, including collection resources, MAY be identified by more than one URI. For example, a resource could be identified by multiple HTTP URLs.

5.2. Collection Resources

Collection resources differ from other resources in that they also act as containers. Some HTTP methods apply only to a collection, but some apply to some or all of the resources inside the container defined by the collection. When the scope of a method is not clear, the client can specify what depth to apply. Depth can be either zero levels (only the collection), one level (the collection and directly contained resources), or infinite levels (the collection and all contained resources recursively).

A collection's state consists of at least a set of mappings between path segments and resources, and a set of properties on the collection itself. In this document, a resource B will be said to be contained in the collection resource A if there is a path segment mapping that maps to B and that is contained in A. A collection MUST contain at most one mapping for a given path segment, i.e., it is illegal to have the same path segment mapped to more than one resource.

Properties defined on collections behave exactly as do properties on non-collection resources. A collection MAY have additional state such as entity bodies returned by GET.

For all WebDAV-compliant resources A and B, identified by URLs "U" and "V", respectively, such that "V" is equal to "U/SEGMENT", A MUST be a collection that contains a mapping from "SEGMENT" to B. So, if resource B with URL "http://example.com/bar/blah" is WebDAV compliant and if resource A with URL "http://example.com/bar/" is WebDAV compliant, then resource A must be a collection and must contain exactly one mapping from "blah" to B.

Although commonly a mapping consists of a single segment and a resource, in general, a mapping consists of a set of segments and a resource. This allows a server to treat a set of segments as equivalent (i.e., either all of the segments are mapped to the same resource, or none of the segments are mapped to a resource). For example, a server that performs case-folding on segments will treat the segments "ab", "Ab", "aB", and "AB" as equivalent. A client can then use any of these segments to identify the resource. Note that a PROPFIND result will select one of these equivalent segments to identify the mapping, so there will be one PROPFIND response element per mapping, not one per segment in the mapping.

Collection resources MAY have mappings to non-WebDAV-compliant resources in the HTTP URL namespace hierarchy but are not required to do so. For example, if resource X with URL "http://example.com/bar/blah" is not WebDAV compliant and resource A with "URL http://example.com/bar/" identifies a WebDAV collection, then A may or may not have a mapping from "blah" to X.

If a WebDAV-compliant resource has no WebDAV-compliant internal members in the HTTP URL namespace hierarchy, then the WebDAV-compliant resource is not required to be a collection.

There is a standing convention that when a collection is referred to by its name without a trailing slash, the server MAY handle the request as if the trailing slash were present. In this case, it SHOULD return a Content-Location header in the response, pointing to the URL ending with the "/". For example, if a client invokes a method on http://example.com/blah (no trailing slash), the server may respond as if the operation were invoked on http://example.com/blah/ (trailing slash), and should return a Content-Location header with the value http://example.com/blah/. Wherever a server produces a URL referring to a collection, the server SHOULD include the trailing slash. In general, clients SHOULD use the trailing slash form of collection names. If clients do not use the trailing slash form the client needs to be prepared to see a redirect response. Clients will

find the DAV:resourcetype property more reliable than the URL to find out if a resource is a collection.

Clients MUST be able to support the case where WebDAV resources are contained inside non-WebDAV resources. For example, if an OPTIONS response from "http://example.com/servlet/dav/collection" indicates WebDAV support, the client cannot assume that "http://example.com/servlet/dav/" or its parent necessarily are WebDAV collections.

A typical scenario in which mapped URLs do not appear as members of their parent collection is the case where a server allows links or redirects to non-WebDAV resources. For instance, "/col/link" might not appear as a member of "/col/", although the server would respond with a 302 status to a GET request to "/col/link"; thus, the URL "/col/link" would indeed be mapped. Similarly, a dynamically-generated page might have a URL mapping from "/col/index.html", thus this resource might respond with a 200 OK to a GET request yet not appear as a member of "/col/".

Some mappings to even WebDAV-compliant resources might not appear in the parent collection. An example for this case are servers that support multiple alias URLs for each WebDAV-compliant resource. A server may implement case-insensitive URLs, thus "/col/a" and "/col/A" identify the same resource, yet only either "a" or "A" is reported upon listing the members of "/col". In cases where a server treats a set of segments as equivalent, the server MUST expose only one preferred segment per mapping, consistently chosen, in PROPFIND responses.

6. Locking

The ability to lock a resource provides a mechanism for serializing access to that resource. Using a lock, an authoring client can provide a reasonable guarantee that another principal will not modify a resource while it is being edited. In this way, a client can prevent the "lost update" problem.

This specification allows locks to vary over two client-specified parameters, the number of principals involved (exclusive vs. shared) and the type of access to be granted. This document defines locking for only one access type, write. However, the syntax is extensible, and permits the eventual specification of locking for other access types.

6.1. Lock Model

This section provides a concise model for how locking behaves. Later sections will provide more detail on some of the concepts and refer back to these model statements. Normative statements related to LOCK and UNLOCK method handling can be found in the sections on those methods, whereas normative statements that cover any method are gathered here.

1. A lock either directly or indirectly locks a resource.
2. A resource becomes directly locked when a LOCK request to a URL of that resource creates a new lock. The "lock-root" of the new lock is that URL. If at the time of the request, the URL is not mapped to a resource, a new empty resource is created and directly locked.
3. An exclusive lock (Section 6.2) conflicts with any other kind of lock on the same resource, whether either lock is direct or indirect. A server MUST NOT create conflicting locks on a resource.
4. For a collection that is locked with a depth-infinity lock L, all member resources are indirectly locked. Changes in membership of such a collection affect the set of indirectly locked resources:
 - * If a member resource is added to the collection, the new member resource MUST NOT already have a conflicting lock, because the new resource MUST become indirectly locked by L.
 - * If a member resource stops being a member of the collection, then the resource MUST no longer be indirectly locked by L.
5. Each lock is identified by a single globally unique lock token (Section 6.5).
6. An UNLOCK request deletes the lock with the specified lock token. After a lock is deleted, no resource is locked by that lock.
7. A lock token is "submitted" in a request when it appears in an "If" header (Section 7, "Write Lock", discusses when token submission is required for write locks).
8. If a request causes the lock-root of any lock to become an unmapped URL, then the lock MUST also be deleted by that request.

6.2. Exclusive vs. Shared Locks

The most basic form of lock is an exclusive lock. Exclusive locks avoid having to deal with content change conflicts, without requiring any coordination other than the methods described in this specification.

However, there are times when the goal of a lock is not to exclude others from exercising an access right but rather to provide a mechanism for principals to indicate that they intend to exercise their access rights. Shared locks are provided for this case. A shared lock allows multiple principals to receive a lock. Hence any principal that has both access privileges and a valid lock can use the locked resource.

With shared locks, there are two trust sets that affect a resource. The first trust set is created by access permissions. Principals who are trusted, for example, may have permission to write to the resource. Among those who have access permission to write to the resource, the set of principals who have taken out a shared lock also must trust each other, creating a (typically) smaller trust set within the access permission write set.

Starting with every possible principal on the Internet, in most situations the vast majority of these principals will not have write access to a given resource. Of the small number who do have write access, some principals may decide to guarantee their edits are free from overwrite conflicts by using exclusive write locks. Others may decide they trust their collaborators will not overwrite their work (the potential set of collaborators being the set of principals who have write permission) and use a shared lock, which informs their collaborators that a principal may be working on the resource.

The WebDAV extensions to HTTP do not need to provide all of the communications paths necessary for principals to coordinate their activities. When using shared locks, principals may use any out-of-band communication channel to coordinate their work (e.g., face-to-face interaction, written notes, post-it notes on the screen, telephone conversation, email, etc.) The intent of a shared lock is to let collaborators know who else may be working on a resource.

Shared locks are included because experience from Web-distributed authoring systems has indicated that exclusive locks are often too rigid. An exclusive lock is used to enforce a particular editing process: take out an exclusive lock, read the resource, perform edits, write the resource, release the lock. This editing process has the problem that locks are not always properly released, for example, when a program crashes or when a lock creator leaves without

unlocking a resource. While both timeouts (Section 6.6) and administrative action can be used to remove an offending lock, neither mechanism may be available when needed; the timeout may be long or the administrator may not be available.

A successful request for a new shared lock MUST result in the generation of a unique lock associated with the requesting principal. Thus, if five principals have taken out shared write locks on the same resource, there will be five locks and five lock tokens, one for each principal.

6.3. Required Support

A WebDAV-compliant resource is not required to support locking in any form. If the resource does support locking, it may choose to support any combination of exclusive and shared locks for any access types.

The reason for this flexibility is that locking policy strikes to the very heart of the resource management and versioning systems employed by various storage repositories. These repositories require control over what sort of locking will be made available. For example, some repositories only support shared write locks, while others only provide support for exclusive write locks, while yet others use no locking at all. As each system is sufficiently different to merit exclusion of certain locking features, this specification leaves locking as the sole axis of negotiation within WebDAV.

6.4. Lock Creator and Privileges

The creator of a lock has special privileges to use the lock to modify the resource. When a locked resource is modified, a server MUST check that the authenticated principal matches the lock creator (in addition to checking for valid lock token submission).

The server MAY allow privileged users other than the lock creator to destroy a lock (for example, the resource owner or an administrator). The 'unlock' privilege in [RFC3744] was defined to provide that permission.

There is no requirement for servers to accept LOCK requests from all users or from anonymous users.

Note that having a lock does not confer full privilege to modify the locked resource. Write access and other privileges MUST be enforced through normal privilege or authentication mechanisms, not based on the possible obscurity of lock token values.

6.5. Lock Tokens

A lock token is a type of state token that identifies a particular lock. Each lock has exactly one unique lock token generated by the server. Clients **MUST NOT** attempt to interpret lock tokens in any way.

Lock token URIs **MUST** be unique across all resources for all time. This uniqueness constraint allows lock tokens to be submitted across resources and servers without fear of confusion. Since lock tokens are unique, a client **MAY** submit a lock token in an If header on a resource other than the one that returned it.

When a LOCK operation creates a new lock, the new lock token is returned in the Lock-Token response header defined in Section 10.5, and also in the body of the response.

Servers **MAY** make lock tokens publicly readable (e.g., in the DAV:lockdiscovery property). One use case for making lock tokens readable is so that a long-lived lock can be removed by the resource owner (the client that obtained the lock might have crashed or disconnected before cleaning up the lock). Except for the case of using UNLOCK under user guidance, a client **SHOULD NOT** use a lock token created by another client instance.

This specification encourages servers to create Universally Unique Identifiers (UUIDs) for lock tokens, and to use the URI form defined by "A Universally Unique Identifier (UUID) URN Namespace" ([RFC4122]). However, servers are free to use any URI (e.g., from another scheme) so long as it meets the uniqueness requirements. For example, a valid lock token might be constructed using the "opaquelocktoken" scheme defined in Appendix C.

Example: "urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6"

6.6. Lock Timeout

A lock **MAY** have a limited lifetime. The lifetime is suggested by the client when creating or refreshing the lock, but the server ultimately chooses the timeout value. Timeout is measured in seconds remaining until lock expiration.

The timeout counter **MUST** be restarted if a refresh lock request is successful (see Section 9.10.2). The timeout counter **SHOULD NOT** be restarted at any other time.

If the timeout expires, then the lock **SHOULD** be removed. In this case the server **SHOULD** act as if an UNLOCK method was executed by the

server on the resource using the lock token of the timed-out lock, performed with its override authority.

Servers are advised to pay close attention to the values submitted by clients, as they will be indicative of the type of activity the client intends to perform. For example, an applet running in a browser may need to lock a resource, but because of the instability of the environment within which the applet is running, the applet may be turned off without warning. As a result, the applet is likely to ask for a relatively small timeout value so that if the applet dies, the lock can be quickly harvested. However, a document management system is likely to ask for an extremely long timeout because its user may be planning on going offline.

A client **MUST NOT** assume that just because the timeout has expired, the lock has immediately been removed.

Likewise, a client **MUST NOT** assume that just because the timeout has not expired, the lock still exists. Clients **MUST** assume that locks can arbitrarily disappear at any time, regardless of the value given in the Timeout header. The Timeout header only indicates the behavior of the server if extraordinary circumstances do not occur. For example, a sufficiently privileged user may remove a lock at any time, or the system may crash in such a way that it loses the record of the lock's existence.

6.7. Lock Capability Discovery

Since server lock support is optional, a client trying to lock a resource on a server can either try the lock and hope for the best, or perform some form of discovery to determine what lock capabilities the server supports. This is known as lock capability discovery. A client can determine what lock types the server supports by retrieving the DAV:supportedlock property.

Any DAV-compliant resource that supports the LOCK method **MUST** support the DAV:supportedlock property.

6.8. Active Lock Discovery

If another principal locks a resource that a principal wishes to access, it is useful for the second principal to be able to find out who the first principal is. For this purpose the DAV:lockdiscovery property is provided. This property lists all outstanding locks, describes their type, and **MAY** even provide the lock tokens.

Any DAV-compliant resource that supports the LOCK method **MUST** support the DAV:lockdiscovery property.

7. Write Lock

This section describes the semantics specific to the write lock type. The write lock is a specific instance of a lock type, and is the only lock type described in this specification.

An exclusive write lock protects a resource: it prevents changes by any principal other than the lock creator and in any case where the lock token is not submitted (e.g., by a client process other than the one holding the lock).

Clients MUST submit a lock-token they are authorized to use in any request that modifies a write-locked resource. The list of modifications covered by a write-lock include:

1. A change to any of the following aspects of any write-locked resource:
 - * any variant,
 - * any dead property,
 - * any live property that is lockable (a live property is lockable unless otherwise defined.)
2. For collections, any modification of an internal member URI. An internal member URI of a collection is considered to be modified if it is added, removed, or identifies a different resource. More discussion on write locks and collections is found in Section 7.4.
3. A modification of the mapping of the root of the write lock, either to another resource or to no resource (e.g., DELETE).

Of the methods defined in HTTP and WebDAV, PUT, POST, PROPPATCH, LOCK, UNLOCK, MOVE, COPY (for the destination resource), DELETE, and MKCOL are affected by write locks. All other HTTP/WebDAV methods defined so far -- GET in particular -- function independently of a write lock.

The next few sections describe in more specific terms how write locks interact with various operations.

7.1. Write Locks and Properties

While those without a write lock may not alter a property on a resource it is still possible for the values of live properties to change, even while locked, due to the requirements of their schemas. Only dead properties and live properties defined as lockable are guaranteed not to change while write locked.

7.2. Avoiding Lost Updates

Although the write locks provide some help in preventing lost updates, they cannot guarantee that updates will never be lost. Consider the following scenario:

Two clients A and B are interested in editing the resource 'index.html'. Client A is an HTTP client rather than a WebDAV client, and so does not know how to perform locking.

Client A doesn't lock the document, but does a GET, and begins editing.

Client B does LOCK, performs a GET and begins editing.

Client B finishes editing, performs a PUT, then an UNLOCK.

Client A performs a PUT, overwriting and losing all of B's changes.

There are several reasons why the WebDAV protocol itself cannot prevent this situation. First, it cannot force all clients to use locking because it must be compatible with HTTP clients that do not comprehend locking. Second, it cannot require servers to support locking because of the variety of repository implementations, some of which rely on reservations and merging rather than on locking. Finally, being stateless, it cannot enforce a sequence of operations like LOCK / GET / PUT / UNLOCK.

WebDAV servers that support locking can reduce the likelihood that clients will accidentally overwrite each other's changes by requiring clients to lock resources before modifying them. Such servers would effectively prevent HTTP 1.0 and HTTP 1.1 clients from modifying resources.

WebDAV clients can be good citizens by using a lock / retrieve / write /unlock sequence of operations (at least by default) whenever they interact with a WebDAV server that supports locking.

HTTP 1.1 clients can be good citizens, avoiding overwriting other clients' changes, by using entity tags in If-Match headers with any requests that would modify resources.

Information managers may attempt to prevent overwrites by implementing client-side procedures requiring locking before modifying WebDAV resources.

7.3. Write Locks and Unmapped URLs

WebDAV provides the ability to send a LOCK request to an unmapped URL in order to reserve the name for use. This is a simple way to avoid the lost-update problem on the creation of a new resource (another way is to use If-None-Match header specified in Section 14.26 of [RFC2616]). It has the side benefit of locking the new resource immediately for use of the creator.

Note that the lost-update problem is not an issue for collections because MKCOL can only be used to create a collection, not to overwrite an existing collection. When trying to lock a collection upon creation, clients can attempt to increase the likelihood of getting the lock by pipelining the MKCOL and LOCK requests together (but because this doesn't convert two separate operations into one atomic operation, there's no guarantee this will work).

A successful lock request to an unmapped URL MUST result in the creation of a locked (non-collection) resource with empty content. Subsequently, a successful PUT request (with the correct lock token) provides the content for the resource. Note that the LOCK request has no mechanism for the client to provide Content-Type or Content-Language, thus the server will use defaults or empty values and rely on the subsequent PUT request for correct values.

A resource created with a LOCK is empty but otherwise behaves in every way as a normal resource. It behaves the same way as a resource created by a PUT request with an empty body (and where a Content-Type and Content-Language was not specified), followed by a LOCK request to the same resource. Following from this model, a locked empty resource:

- o Can be read, deleted, moved, and copied, and in all ways behaves as a regular non-collection resource.
- o Appears as a member of its parent collection.
- o SHOULD NOT disappear when its lock goes away (clients must therefore be responsible for cleaning up their own mess, as with any other operation or any non-empty resource).

- o MAY NOT have values for properties like DAV:getcontentlanguage that haven't been specified yet by the client.
- o Can be updated (have content added) with a PUT request.
- o MUST NOT be converted into a collection. The server MUST fail a MKCOL request (as it would with a MKCOL request to any existing non-collection resource).
- o MUST have defined values for DAV:lockdiscovery and DAV:supportedlock properties.
- o The response MUST indicate that a resource was created, by use of the "201 Created" response code (a LOCK request to an existing resource instead will result in 200 OK). The body must still include the DAV:lockdiscovery property, as with a LOCK request to an existing resource.

The client is expected to update the locked empty resource shortly after locking it, using PUT and possibly PROPPATCH.

Alternatively and for backwards compatibility to [RFC2518], servers MAY implement Lock-Null Resources (LNRs) instead (see definition in Appendix D). Clients can easily interoperate both with servers that support the old model LNRs and the recommended model of "locked empty resources" by only attempting PUT after a LOCK to an unmapped URL, not MKCOL or GET, and by not relying on specific properties of LNRs.

7.4. Write Locks and Collections

There are two kinds of collection write locks. A depth-0 write lock on a collection protects the collection properties plus the internal member URLs of that one collection, while not protecting the content or properties of member resources (if the collection itself has any entity bodies, those are also protected). A depth-infinity write lock on a collection provides the same protection on that collection and also provides write lock protection on every member resource.

Expressed otherwise, a write lock of either kind protects any request that would create a new resource in a write locked collection, any request that would remove an internal member URL of a write locked collection, and any request that would change the segment name of any internal member.

Thus, a collection write lock protects all the following actions:

- o DELETE a collection's direct internal member,

- o MOVE an internal member out of the collection,
- o MOVE an internal member into the collection,
- o MOVE to rename an internal member within a collection,
- o COPY an internal member into a collection, and
- o PUT or MKCOL request that would create a new internal member.

The collection's lock token is required in addition to the lock token on the internal member itself, if it is locked separately.

In addition, a depth-infinity lock affects all write operations to all members of the locked collection. With a depth-infinity lock, the resource identified by the root of the lock is directly locked, and all its members are indirectly locked.

- o Any new resource added as a descendant of a depth-infinity locked collection becomes indirectly locked.
- o Any indirectly locked resource moved out of the locked collection into an unlocked collection is thereafter unlocked.
- o Any indirectly locked resource moved out of a locked source collection into a depth-infinity locked target collection remains indirectly locked but is now protected by the lock on the target collection (the target collection's lock token will thereafter be required to make further changes).

If a depth-infinity write LOCK request is issued to a collection containing member URLs identifying resources that are currently locked in a manner that conflicts with the new lock (see Section 6.1, point 3), the request MUST fail with a 423 (Locked) status code, and the response SHOULD contain the 'no-conflicting-lock' precondition.

If a lock request causes the URL of a resource to be added as an internal member URL of a depth-infinity locked collection, then the new resource MUST be automatically protected by the lock. For example, if the collection /a/b/ is write locked and the resource /c is moved to /a/b/c, then resource /a/b/c will be added to the write lock.

7.5. Write Locks and the If Request Header

A user agent has to demonstrate knowledge of a lock when requesting an operation on a locked resource. Otherwise, the following scenario might occur. In the scenario, program A, run by User A, takes out a write lock on a resource. Program B, also run by User A, has no knowledge of the lock taken out by program A, yet performs a PUT to the locked resource. In this scenario, the PUT succeeds because locks are associated with a principal, not a program, and thus program B, because it is acting with principal A's credential, is allowed to perform the PUT. However, had program B known about the lock, it would not have overwritten the resource, preferring instead to present a dialog box describing the conflict to the user. Due to this scenario, a mechanism is needed to prevent different programs from accidentally ignoring locks taken out by other programs with the same authorization.

In order to prevent these collisions, a lock token MUST be submitted by an authorized principal for all locked resources that a method may change or the method MUST fail. A lock token is submitted when it appears in an If header. For example, if a resource is to be moved and both the source and destination are locked, then two lock tokens must be submitted in the If header, one for the source and the other for the destination.

7.5.1. Example - Write Lock and COPY

>>Request

```
COPY /~fielding/index.html HTTP/1.1
Host: www.example.com
Destination: http://www.example.com/users/f/fielding/index.html
If: <http://www.example.com/users/f/fielding/index.html>
    (<urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6>)
```

>>Response

```
HTTP/1.1 204 No Content
```

In this example, even though both the source and destination are locked, only one lock token must be submitted (the one for the lock on the destination). This is because the source resource is not modified by a COPY, and hence unaffected by the write lock. In this example, user agent authentication has previously occurred via a mechanism outside the scope of the HTTP protocol, in the underlying transport layer.

7.5.2. Example - Deleting a Member of a Locked Collection

Consider a collection `/locked` with an exclusive, depth-infinity write lock, and an attempt to delete an internal member `/locked/member`:

>>Request

```
DELETE /locked/member HTTP/1.1
Host: example.com
```

>>Response

```
HTTP/1.1 423 Locked
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx
```

```
<?xml version="1.0" encoding="utf-8" ?>
<D:error xmlns:D="DAV:">
  <D:lock-token-submitted>
    <D:href>/locked/</D:href>
  </D:lock-token-submitted>
</D:error>
```

Thus, the client would need to submit the lock token with the request to make it succeed. To do that, various forms of the If header (see Section 10.4) could be used.

"No-Tag-List" format:

```
If: (<urn:uuid:150852e2-3847-42d5-8cbe-0f4f296f26cf>)
```

"Tagged-List" format, for `http://example.com/locked/`:

```
If: <http://example.com/locked/>
    (<urn:uuid:150852e2-3847-42d5-8cbe-0f4f296f26cf>)
```

"Tagged-List" format, for `http://example.com/locked/member`:

```
If: <http://example.com/locked/member>
    (<urn:uuid:150852e2-3847-42d5-8cbe-0f4f296f26cf>)
```

Note that, for the purpose of submitting the lock token, the actual form doesn't matter; what's relevant is that the lock token appears in the If header, and that the If header itself evaluates to true.

7.6. Write Locks and COPY/MOVE

A COPY method invocation MUST NOT duplicate any write locks active on the source. However, as previously noted, if the COPY copies the resource into a collection that is locked with a depth-infinity lock, then the resource will be added to the lock.

A successful MOVE request on a write locked resource MUST NOT move the write lock with the resource. However, if there is an existing lock at the destination, the server MUST add the moved resource to the destination lock scope. For example, if the MOVE makes the resource a child of a collection that has a depth-infinity lock, then the resource will be added to that collection's lock. Additionally, if a resource with a depth-infinity lock is moved to a destination that is within the scope of the same lock (e.g., within the URL namespace tree covered by the lock), the moved resource will again be added to the lock. In both these examples, as specified in Section 7.5, an If header must be submitted containing a lock token for both the source and destination.

7.7. Refreshing Write Locks

A client MUST NOT submit the same write lock request twice. Note that a client is always aware it is resubmitting the same lock request because it must include the lock token in the If header in order to make the request for a resource that is already locked.

However, a client may submit a LOCK request with an If header but without a body. A server receiving a LOCK request with no body MUST NOT create a new lock -- this form of the LOCK request is only to be used to "refresh" an existing lock (meaning, at minimum, that any timers associated with the lock MUST be reset).

Clients may submit Timeout headers of arbitrary value with their lock refresh requests. Servers, as always, may ignore Timeout headers submitted by the client, and a server MAY refresh a lock with a timeout period that is different than the previous timeout period used for the lock, provided it advertises the new value in the LOCK refresh response.

If an error is received in response to a refresh LOCK request, the client MUST NOT assume that the lock was refreshed.

8. General Request and Response Handling

8.1. Precedence in Error Handling

Servers MUST return authorization errors in preference to other errors. This avoids leaking information about protected resources (e.g., a client that finds that a hidden resource exists by seeing a 423 Locked response to an anonymous request to the resource).

8.2. Use of XML

In HTTP/1.1, method parameter information was exclusively encoded in HTTP headers. Unlike HTTP/1.1, WebDAV encodes method parameter information either in an XML ([REC-XML]) request entity body, or in an HTTP header. The use of XML to encode method parameters was motivated by the ability to add extra XML elements to existing structures, providing extensibility; and by XML's ability to encode information in ISO 10646 character sets, providing internationalization support.

In addition to encoding method parameters, XML is used in WebDAV to encode the responses from methods, providing the extensibility and internationalization advantages of XML for method output, as well as input.

When XML is used for a request or response body, the Content-Type type SHOULD be application/xml. Implementations MUST accept both text/xml and application/xml in request and response bodies. Use of text/xml is deprecated.

All DAV-compliant clients and resources MUST use XML parsers that are compliant with [REC-XML] and [REC-XML-NAMES]. All XML used in either requests or responses MUST be, at minimum, well formed and use namespaces correctly. If a server receives XML that is not well-formed, then the server MUST reject the entire request with a 400 (Bad Request). If a client receives XML that is not well-formed in a response, then the client MUST NOT assume anything about the outcome of the executed method and SHOULD treat the server as malfunctioning.

Note that processing XML submitted by an untrusted source may cause risks connected to privacy, security, and service quality (see Section 20). Servers MAY reject questionable requests (even though they consist of well-formed XML), for instance, with a 400 (Bad Request) status code and an optional response body explaining the problem.

8.3. URL Handling

URLs appear in many places in requests and responses. Interoperability experience with [RFC2518] showed that many clients parsing Multi-Status responses did not fully implement the full Reference Resolution defined in Section 5 of [RFC3986]. Thus, servers in particular need to be careful in handling URLs in responses, to ensure that clients have enough context to be able to interpret all the URLs. The rules in this section apply not only to resource URLs in the 'href' element in Multi-Status responses, but also to the Destination and If header resource URLs.

The sender has a choice between two approaches: using a relative reference, which is resolved against the Request-URI, or a full URI. A server MUST ensure that every 'href' value within a Multi-Status response uses the same format.

WebDAV only uses one form of relative reference in its extensions, the absolute path.

```
Simple-ref = absolute-URI | ( path-absolute [ "?" query ] )
```

The absolute-URI, path-absolute and query productions are defined in Sections 4.3, 3.3, and 3.4 of [RFC3986].

Within Simple-ref productions, senders MUST NOT:

- o use dot-segments (".", ".."), or
- o have prefixes that do not match the Request-URI (using the comparison rules defined in Section 3.2.3 of [RFC2616]).

Identifiers for collections SHOULD end in a '/' character.

8.3.1. Example - Correct URL Handling

Consider the collection `http://example.com/sample/` with the internal member URL `http://example.com/sample/a%20test` and the PROPFIND request below:

>>Request:

```
PROPFIND /sample/ HTTP/1.1
Host: example.com
Depth: 1
```


In this case, the server should return two 'href' elements containing either

- o 'http://example.com/sample/' and 'http://example.com/sample/a%20test', or
- o '/sample/' and '/sample/a%20test'

Note that even though the server may be storing the member resource internally as 'a test', it has to be percent-encoded when used inside a URI reference (see Section 2.1 of [RFC3986]). Also note that a legal URI may still contain characters that need to be escaped within XML character data, such as the ampersand character.

8.4. Required Bodies in Requests

Some of these new methods do not define bodies. Servers MUST examine all requests for a body, even when a body was not expected. In cases where a request body is present but would be ignored by a server, the server MUST reject the request with 415 (Unsupported Media Type). This informs the client (which may have been attempting to use an extension) that the body could not be processed as the client intended.

8.5. HTTP Headers for Use in WebDAV

HTTP defines many headers that can be used in WebDAV requests and responses. Not all of these are appropriate in all situations and some interactions may be undefined. Note that HTTP 1.1 requires the Date header in all responses if possible (see Section 14.18, [RFC2616]).

The server MUST do authorization checks before checking any HTTP conditional header.

8.6. ETag

HTTP 1.1 recommends the use of ETags rather than modification dates, for cache control, and there are even stronger reasons to prefer ETags for authoring. Correct use of ETags is even more important in a distributed authoring environment, because ETags are necessary along with locks to avoid the lost-update problem. A client might fail to renew a lock, for example, when the lock times out and the client is accidentally offline or in the middle of a long upload. When a client fails to renew the lock, it's quite possible the resource can still be relocked and the user can go on editing, as long as no changes were made in the meantime. ETags are required for the client to be able to distinguish this case. Otherwise, the

client is forced to ask the user whether to overwrite the resource on the server without even being able to tell the user if it has changed. Timestamps do not solve this problem nearly as well as ETags.

Strong ETags are much more useful for authoring use cases than weak ETags (see Section 13.3.3 of [RFC2616]). Semantic equivalence can be a useful concept but that depends on the document type and the application type, and interoperability might require some agreement or standard outside the scope of this specification and HTTP. Note also that weak ETags have certain restrictions in HTTP, e.g., these cannot be used in If-Match headers.

Note that the meaning of an ETag in a PUT response is not clearly defined either in this document or in RFC 2616 (i.e., whether the ETag means that the resource is octet-for-octet equivalent to the body of the PUT request, or whether the server could have made minor changes in the formatting or content of the document upon storage). This is an HTTP issue, not purely a WebDAV issue.

Because clients may be forced to prompt users or throw away changed content if the ETag changes, a WebDAV server SHOULD NOT change the ETag (or the Last-Modified time) for a resource that has an unchanged body and location. The ETag represents the state of the body or contents of the resource. There is no similar way to tell if properties have changed.

8.7. Including Error Response Bodies

HTTP and WebDAV did not use the bodies of most error responses for machine-parsable information until the specification for Versioning Extensions to WebDAV introduced a mechanism to include more specific information in the body of an error response (Section 1.6 of [RFC3253]). The error body mechanism is appropriate to use with any error response that may take a body but does not already have a body defined. The mechanism is particularly appropriate when a status code can mean many things (for example, 400 Bad Request can mean required headers are missing, headers are incorrectly formatted, or much more). This error body mechanism is covered in Section 16.

8.8. Impact of Namespace Operations on Cache Validators

Note that the HTTP response headers "Etag" and "Last-Modified" (see [RFC2616], Sections 14.19 and 14.29) are defined per URL (not per resource), and are used by clients for caching. Therefore servers must ensure that executing any operation that affects the URL namespace (such as COPY, MOVE, DELETE, PUT, or MKCOL) does preserve their semantics, in particular:

- o For any given URL, the "Last-Modified" value MUST increment every time the representation returned upon GET changes (within the limits of timestamp resolution).
- o For any given URL, an "ETag" value MUST NOT be reused for different representations returned by GET.

In practice this means that servers

- o might have to increment "Last-Modified" timestamps for every resource inside the destination namespace of a namespace operation unless it can do so more selectively, and
- o similarly, might have to re-assign "ETag" values for these resources (unless the server allocates entity tags in a way so that they are unique across the whole URL namespace managed by the server).

Note that these considerations also apply to specific use cases, such as using PUT to create a new resource at a URL that has been mapped before, but has been deleted since then.

Finally, WebDAV properties (such as DAV:getetag and DAV:getlastmodified) that inherit their semantics from HTTP headers must behave accordingly.

9. HTTP Methods for Distributed Authoring

9.1. PROPFIND Method

The PROPFIND method retrieves properties defined on the resource identified by the Request-URI, if the resource does not have any internal members, or on the resource identified by the Request-URI and potentially its member resources, if the resource is a collection that has internal member URLs. All DAV-compliant resources MUST support the PROPFIND method and the propfind XML element (Section 14.20) along with all XML elements defined for use with that element.

A client MUST submit a Depth header with a value of "0", "1", or "infinity" with a PROPFIND request. Servers MUST support "0" and "1" depth requests on WebDAV-compliant resources and SHOULD support "infinity" requests. In practice, support for infinite-depth requests MAY be disabled, due to the performance and security concerns associated with this behavior. Servers SHOULD treat a request without a Depth header as if a "Depth: infinity" header was included.

A client may submit a 'propfind' XML element in the body of the request method describing what information is being requested. It is possible to:

- o Request particular property values, by naming the properties desired within the 'prop' element (the ordering of properties in here MAY be ignored by the server),
- o Request property values for those properties defined in this specification (at a minimum) plus dead properties, by using the 'allprop' element (the 'include' element can be used with 'allprop' to instruct the server to also include additional live properties that may not have been returned otherwise),
- o Request a list of names of all the properties defined on the resource, by using the 'propname' element.

A client may choose not to submit a request body. An empty PROPFIND request body MUST be treated as if it were an 'allprop' request.

Note that 'allprop' does not return values for all live properties. WebDAV servers increasingly have expensively-calculated or lengthy properties (see [RFC3253] and [RFC3744]) and do not return all properties already. Instead, WebDAV clients can use propname requests to discover what live properties exist, and request named properties when retrieving values. For a live property defined elsewhere, that definition can specify whether or not that live property would be returned in 'allprop' requests.

All servers MUST support returning a response of content type text/xml or application/xml that contains a multistatus XML element that describes the results of the attempts to retrieve the various properties.

If there is an error retrieving a property, then a proper error result MUST be included in the response. A request to retrieve the value of a property that does not exist is an error and MUST be noted with a 'response' XML element that contains a 404 (Not Found) status value.

Consequently, the 'multistatus' XML element for a collection resource MUST include a 'response' XML element for each member URL of the collection, to whatever depth was requested. It SHOULD NOT include any 'response' elements for resources that are not WebDAV-compliant. Each 'response' element MUST contain an 'href' element that contains the URL of the resource on which the properties in the prop XML element are defined. Results for a PROPFIND on a collection resource are returned as a flat list whose order of entries is not

significant. Note that a resource may have only one value for a property of a given name, so the property may only show up once in PROPFIND responses.

Properties may be subject to access control. In the case of 'allprop' and 'propname' requests, if a principal does not have the right to know whether a particular property exists, then the property MAY be silently excluded from the response.

Some PROPFIND results MAY be cached, with care, as there is no cache validation mechanism for most properties. This method is both safe and idempotent (see Section 9.1 of [RFC2616]).

9.1.1.1. PROPFIND Status Codes

This section, as with similar sections for other methods, provides some guidance on error codes and preconditions or postconditions (defined in Section 16) that might be particularly useful with PROPFIND.

403 Forbidden - A server MAY reject PROPFIND requests on collections with depth header of "Infinity", in which case it SHOULD use this error with the precondition code 'propfind-finite-depth' inside the error body.

9.1.1.2. Status Codes for Use in 'propstat' Element

In PROPFIND responses, information about individual properties is returned inside 'propstat' elements (see Section 14.22), each containing an individual 'status' element containing information about the properties appearing in it. The list below summarizes the most common status codes used inside 'propstat'; however, clients should be prepared to handle other 2/3/4/5xx series status codes as well.

200 OK - A property exists and/or its value is successfully returned.

401 Unauthorized - The property cannot be viewed without appropriate authorization.

403 Forbidden - The property cannot be viewed regardless of authentication.

404 Not Found - The property does not exist.

9.1.3. Example - Retrieving Named Properties

>>Request

```

PROPFIND /file HTTP/1.1
Host: www.example.com
Content-type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<D:propfind xmlns:D="DAV:">
  <D:prop xmlns:R="http://ns.example.com/boxschema/">
    <R:bigbox/>
    <R:author/>
    <R:DingALing/>
    <R:Random/>
  </D:prop>
</D:propfind>

```

>>Response

```

HTTP/1.1 207 Multi-Status
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<D:multistatus xmlns:D="DAV:">
  <D:response xmlns:R="http://ns.example.com/boxschema/">
    <D:href>http://www.example.com/file</D:href>
    <D:propstat>
      <D:prop>
        <R:bigbox>
          <R:BoxType>Box type A</R:BoxType>
        </R:bigbox>
        <R:author>
          <R:Name>J.J. Johnson</R:Name>
        </R:author>
      </D:prop>
      <D:status>HTTP/1.1 200 OK</D:status>
    </D:propstat>
    <D:propstat>
      <D:prop><R:DingALing/><R:Random/></D:prop>
      <D:status>HTTP/1.1 403 Forbidden</D:status>
      <D:responsedescription> The user does not have access to the
      DingALing property.
    </D:responsedescription>
    </D:propstat>
  </D:response>
</D:multistatus>

```

```
</D:response>
<D:responsedescription> There has been an access violation error.
</D:responsedescription>
</D:multistatus>
```

In this example, PROPFIND is executed on a non-collection resource `http://www.example.com/file`. The propfind XML element specifies the name of four properties whose values are being requested. In this case, only two properties were returned, since the principal issuing the request did not have sufficient access rights to see the third and fourth properties.

9.1.4. Example - Using 'propname' to Retrieve All Property Names

>>Request

```
PROPFIND /container/ HTTP/1.1
Host: www.example.com
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<propfind xmlns="DAV:">
  <propname/>
</propfind>
```

>>Response

```
HTTP/1.1 207 Multi-Status
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<multistatus xmlns="DAV:">
  <response>
    <href>http://www.example.com/container/</href>
    <propstat>
      <prop xmlns:R="http://ns.example.com/boxschema/">
        <R:bigbox/>
        <R:author/>
        <creationdate/>
        <displayname/>
        <resourcetype/>
        <supportedlock/>
      </prop>
    <status>HTTP/1.1 200 OK</status>
```

```

    </propstat>
  </response>
</response>
  <href>http://www.example.com/container/front.html</href>
  <propstat>
    <prop xmlns:R="http://ns.example.com/boxschema/">
      <R:bigbox/>
      <creationdate/>
      <displayname/>
      <getcontentlength/>
      <getcontenttype/>
      <getetag/>
      <getlastmodified/>
      <resourcetype/>
      <supportedlock/>
    </prop>
    <status>HTTP/1.1 200 OK</status>
  </propstat>
</response>
</multistatus>

```

In this example, PROPFIND is invoked on the collection resource `http://www.example.com/container/`, with a `propfind` XML element containing the `propname` XML element, meaning the name of all properties should be returned. Since no `Depth` header is present, it assumes its default value of "infinity", meaning the name of the properties on the collection and all its descendants should be returned.

Consistent with the previous example, resource `http://www.example.com/container/` has six properties defined on it: `bigbox` and `author` in the "http://ns.example.com/boxschema/" namespace, and `creationdate`, `displayname`, `resourcetype`, and `supportedlock` in the "DAV:" namespace.

The resource `http://www.example.com/container/index.html`, a member of the "container" collection, has nine properties defined on it, `bigbox` in the "http://ns.example.com/boxschema/" namespace and `creationdate`, `displayname`, `getcontentlength`, `getcontenttype`, `getetag`, `getlastmodified`, `resourcetype`, and `supportedlock` in the "DAV:" namespace.

This example also demonstrates the use of XML namespace scoping and the default namespace. Since the "xmlns" attribute does not contain a prefix, the namespace applies by default to all enclosed elements. Hence, all elements that do not explicitly state the namespace to which they belong are members of the "DAV:" namespace.

9.1.5. Example - Using So-called 'allprop'

Note that 'allprop', despite its name, which remains for backward-compatibility, does not return every property, but only dead properties and the live properties defined in this specification.

>>Request

```
PROPFIND /container/ HTTP/1.1
Host: www.example.com
Depth: 1
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<D:propfind xmlns:D="DAV:">
  <D:allprop/>
</D:propfind>
```

>>Response

```
HTTP/1.1 207 Multi-Status
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<D:multistatus xmlns:D="DAV:">
  <D:response>
    <D:href>/container/</D:href>
    <D:propstat>
      <D:prop xmlns:R="http://ns.example.com/boxschema/">
        <R:bigbox><R:BoxType>Box type A</R:BoxType></R:bigbox>
        <R:author><R:Name>Hadrian</R:Name></R:author>
        <D:creationdate>1997-12-01T17:42:21-08:00</D:creationdate>
        <D:displayname>Example collection</D:displayname>
        <D:resourcetype><D:collection/></D:resourcetype>
        <D:supportedlock>
          <D:lockentry>
            <D:lockscope><D:exclusive/></D:lockscope>
            <D:locktype><D:write/></D:locktype>
          </D:lockentry>
          <D:lockentry>
            <D:lockscope><D:shared/></D:lockscope>
            <D:locktype><D:write/></D:locktype>
          </D:lockentry>
        </D:supportedlock>
      </D:prop>
    </D:propstat>
  </D:response>
</D:multistatus>
```

```

    <D:status>HTTP/1.1 200 OK</D:status>
  </D:propstat>
</D:response>
<D:response>
  <D:href>/container/front.html</D:href>
  <D:propstat>
    <D:prop xmlns:R="http://ns.example.com/boxschema/">
      <R:bigbox><R:BoxType>Box type B</R:BoxType>
    </R:bigbox>
    <D:creationdate>1997-12-01T18:27:21-08:00</D:creationdate>
    <D:displayname>Example HTML resource</D:displayname>
    <D:getcontentlength>4525</D:getcontentlength>
    <D:getcontenttype>text/html</D:getcontenttype>
    <D:getetag>"zzyzx"</D:getetag>
    <D:getlastmodified>
      >Mon, 12 Jan 1998 09:25:56 GMT</D:getlastmodified>
    <D:resourcetype/>
    <D:supportedlock>
      <D:lockentry>
        <D:lockscope><D:exclusive/></D:lockscope>
        <D:locktype><D:write/></D:locktype>
      </D:lockentry>
      <D:lockentry>
        <D:lockscope><D:shared/></D:lockscope>
        <D:locktype><D:write/></D:locktype>
      </D:lockentry>
    </D:supportedlock>
  </D:prop>
  <D:status>HTTP/1.1 200 OK</D:status>
</D:propstat>
</D:response>
</D:multistatus>

```

In this example, PROPFIND was invoked on the resource `http://www.example.com/container/` with a Depth header of 1, meaning the request applies to the resource and its children, and a propfind XML element containing the allprop XML element, meaning the request should return the name and value of all the dead properties defined on the resources, plus the name and value of all the properties defined in this specification. This example illustrates the use of relative references in the 'href' elements of the response.

The resource `http://www.example.com/container/` has six properties defined on it: 'bigbox' and 'author' in the "http://ns.example.com/boxschema/" namespace, DAV:creationdate, DAV:displayname, DAV:resourcetype, and DAV:supportedlock.

The last four properties are WebDAV-specific, defined in Section 15. Since GET is not supported on this resource, the get* properties (e.g., DAV:getcontentlength) are not defined on this resource. The WebDAV-specific properties assert that "container" was created on December 1, 1997, at 5:42:21PM, in a time zone 8 hours west of GMT (DAV:creationdate), has a name of "Example collection" (DAV:displayname), a collection resource type (DAV:resourcetype), and supports exclusive write and shared write locks (DAV:supportedlock).

The resource `http://www.example.com/container/front.html` has nine properties defined on it:

'bigbox' in the "`http://ns.example.com/boxschema/`" namespace (another instance of the "bigbox" property type), DAV:creationdate, DAV:displayname, DAV:getcontentlength, DAV:getcontenttype, DAV:getetag, DAV:getlastmodified, DAV:resourcetype, and DAV:supportedlock.

The DAV-specific properties assert that "front.html" was created on December 1, 1997, at 6:27:21PM, in a time zone 8 hours west of GMT (DAV:creationdate), has a name of "Example HTML resource" (DAV:displayname), a content length of 4525 bytes (DAV:getcontentlength), a MIME type of "text/html" (DAV:getcontenttype), an entity tag of "zzyzx" (DAV:getetag), was last modified on Monday, January 12, 1998, at 09:25:56 GMT (DAV:getlastmodified), has an empty resource type, meaning that it is not a collection (DAV:resourcetype), and supports both exclusive write and shared write locks (DAV:supportedlock).

9.1.6. Example - Using 'allprop' with 'include'

>>Request

```
PROPFIND /mycol/ HTTP/1.1
Host: www.example.com
Depth: 1
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxxx
```

```
<?xml version="1.0" encoding="utf-8" ?>
<D:propfind xmlns:D="DAV:">
  <D:allprop/>
  <D:include>
    <D:supported-live-property-set/>
    <D:supported-report-set/>
  </D:include>
</D:propfind>
```

In this example, PROPFIND is executed on the resource `http://www.example.com/mycol/` and its internal member resources. The client requests the values of all live properties defined in this specification, plus all dead properties, plus two more live properties defined in [RFC3253]. The response is not shown.

9.2. PROPPATCH Method

The PROPPATCH method processes instructions specified in the request body to set and/or remove properties defined on the resource identified by the Request-URI.

All DAV-compliant resources MUST support the PROPPATCH method and MUST process instructions that are specified using the `propertyupdate`, `set`, and `remove` XML elements. Execution of the directives in this method is, of course, subject to access control constraints. DAV-compliant resources SHOULD support the setting of arbitrary dead properties.

The request message body of a PROPPATCH method MUST contain the `propertyupdate` XML element.

Servers MUST process PROPPATCH instructions in document order (an exception to the normal rule that ordering is irrelevant). Instructions MUST either all be executed or none executed. Thus, if any error occurs during processing, all executed instructions MUST be undone and a proper error result returned. Instruction processing details can be found in the definition of the `set` and `remove` instructions in Sections 14.23 and 14.26.

If a server attempts to make any of the property changes in a PROPPATCH request (i.e., the request is not rejected for high-level errors before processing the body), the response MUST be a Multi-Status response as described in Section 9.2.1.

This method is idempotent, but not safe (see Section 9.1 of [RFC2616]). Responses to this method MUST NOT be cached.

9.2.1. Status Codes for Use in 'propstat' Element

In PROPPATCH responses, information about individual properties is returned inside 'propstat' elements (see Section 14.22), each containing an individual 'status' element containing information about the properties appearing in it. The list below summarizes the most common status codes used inside 'propstat'; however, clients should be prepared to handle other 2/3/4/5xx series status codes as well.

200 (OK) - The property set or change succeeded. Note that if this appears for one property, it appears for every property in the response, due to the atomicity of PROPPATCH.

403 (Forbidden) - The client, for reasons the server chooses not to specify, cannot alter one of the properties.

403 (Forbidden): The client has attempted to set a protected property, such as DAV:getetag. If returning this error, the server SHOULD use the precondition code 'cannot-modify-protected-property' inside the response body.

409 (Conflict) - The client has provided a value whose semantics are not appropriate for the property.

424 (Failed Dependency) - The property change could not be made because of another property change that failed.

507 (Insufficient Storage) - The server did not have sufficient space to record the property.

9.2.2.2. Example - PROPPATCH

>>Request

```
PROPPATCH /bar.html HTTP/1.1
Host: www.example.com
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<D:propertyupdate xmlns:D="DAV:"
  xmlns:Z="http://ns.example.com/standards/z39.50/">
  <D:set>
    <D:prop>
      <Z:Authors>
        <Z:Author>Jim Whitehead</Z:Author>
        <Z:Author>Roy Fielding</Z:Author>
      </Z:Authors>
    </D:prop>
  </D:set>
  <D:remove>
    <D:prop><Z:Copyright-Owner/></D:prop>
  </D:remove>
</D:propertyupdate>
```

>>Response

```

HTTP/1.1 207 Multi-Status
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<D:multistatus xmlns:D="DAV:"
  xmlns:Z="http://ns.example.com/standards/z39.50/">
  <D:response>
    <D:href>http://www.example.com/bar.html</D:href>
    <D:propstat>
      <D:prop><Z:Authors/></D:prop>
      <D:status>HTTP/1.1 424 Failed Dependency</D:status>
    </D:propstat>
    <D:propstat>
      <D:prop><Z:Copyright-Owner/></D:prop>
      <D:status>HTTP/1.1 409 Conflict</D:status>
    </D:propstat>
    <D:responsedescription> Copyright Owner cannot be deleted or
      altered.</D:responsedescription>
  </D:response>
</D:multistatus>

```

In this example, the client requests the server to set the value of the "Authors" property in the "http://ns.example.com/standards/z39.50/" namespace, and to remove the property "Copyright-Owner" in the same namespace. Since the Copyright-Owner property could not be removed, no property modifications occur. The 424 (Failed Dependency) status code for the Authors property indicates this action would have succeeded if it were not for the conflict with removing the Copyright-Owner property.

9.3. MKCOL Method

MKCOL creates a new collection resource at the location specified by the Request-URI. If the Request-URI is already mapped to a resource, then the MKCOL MUST fail. During MKCOL processing, a server MUST make the Request-URI an internal member of its parent collection, unless the Request-URI is "/". If no such ancestor exists, the method MUST fail. When the MKCOL operation creates a new collection resource, all ancestors MUST already exist, or the method MUST fail with a 409 (Conflict) status code. For example, if a request to create collection /a/b/c/d/ is made, and /a/b/c/ does not exist, the request must fail.

When MKCOL is invoked without a request body, the newly created collection SHOULD have no members.

A MKCOL request message may contain a message body. The precise behavior of a MKCOL request when the body is present is undefined, but limited to creating collections, members of a collection, bodies of members, and properties on the collections or members. If the server receives a MKCOL request entity type it does not support or understand, it MUST respond with a 415 (Unsupported Media Type) status code. If the server decides to reject the request based on the presence of an entity or the type of an entity, it should use the 415 (Unsupported Media Type) status code.

This method is idempotent, but not safe (see Section 9.1 of [RFC2616]). Responses to this method MUST NOT be cached.

9.3.1. MKCOL Status Codes

In addition to the general status codes possible, the following status codes have specific applicability to MKCOL:

201 (Created) - The collection was created.

403 (Forbidden) - This indicates at least one of two conditions: 1) the server does not allow the creation of collections at the given location in its URL namespace, or 2) the parent collection of the Request-URI exists but cannot accept members.

405 (Method Not Allowed) - MKCOL can only be executed on an unmapped URL.

409 (Conflict) - A collection cannot be made at the Request-URI until one or more intermediate collections have been created. The server MUST NOT create those intermediate collections automatically.

415 (Unsupported Media Type) - The server does not support the request body type (although bodies are legal on MKCOL requests, since this specification doesn't define any, the server is likely not to support any given body type).

507 (Insufficient Storage) - The resource does not have sufficient space to record the state of the resource after the execution of this method.

9.3.2. Example - MKCOL

This example creates a collection called /webdisc/xfiles/ on the server www.example.com.

>>Request

```
MKCOL /webdisc/xfiles/ HTTP/1.1
Host: www.example.com
```

>>Response

```
HTTP/1.1 201 Created
```

9.4. GET, HEAD for Collections

The semantics of GET are unchanged when applied to a collection, since GET is defined as, "retrieve whatever information (in the form of an entity) is identified by the Request-URI" [RFC2616]. GET, when applied to a collection, may return the contents of an "index.html" resource, a human-readable view of the contents of the collection, or something else altogether. Hence, it is possible that the result of a GET on a collection will bear no correlation to the membership of the collection.

Similarly, since the definition of HEAD is a GET without a response message body, the semantics of HEAD are unmodified when applied to collection resources.

9.5. POST for Collections

Since by definition the actual function performed by POST is determined by the server and often depends on the particular resource, the behavior of POST when applied to collections cannot be meaningfully modified because it is largely undefined. Thus, the semantics of POST are unmodified when applied to a collection.

9.6. DELETE Requirements

DELETE is defined in [RFC2616], Section 9.7, to "delete the resource identified by the Request-URI". However, WebDAV changes some DELETE handling requirements.

A server processing a successful DELETE request:

- MUST destroy locks rooted on the deleted resource

- MUST remove the mapping from the Request-URI to any resource.

Thus, after a successful DELETE operation (and in the absence of other actions), a subsequent GET/HEAD/PROPFIND request to the target Request-URI MUST return 404 (Not Found).

9.6.1. DELETE for Collections

The DELETE method on a collection MUST act as if a "Depth: infinity" header was used on it. A client MUST NOT submit a Depth header with a DELETE on a collection with any value but infinity.

DELETE instructs that the collection specified in the Request-URI and all resources identified by its internal member URLs are to be deleted.

If any resource identified by a member URL cannot be deleted, then all of the member's ancestors MUST NOT be deleted, so as to maintain URL namespace consistency.

Any headers included with DELETE MUST be applied in processing every resource to be deleted.

When the DELETE method has completed processing, it MUST result in a consistent URL namespace.

If an error occurs deleting a member resource (a resource other than the resource identified in the Request-URI), then the response can be a 207 (Multi-Status). Multi-Status is used here to indicate which internal resources could NOT be deleted, including an error code, which should help the client understand which resources caused the failure. For example, the Multi-Status body could include a response with status 423 (Locked) if an internal resource was locked.

The server MAY return a 4xx status response, rather than a 207, if the request failed completely.

424 (Failed Dependency) status codes SHOULD NOT be in the 207 (Multi-Status) response for DELETE. They can be safely left out because the client will know that the ancestors of a resource could not be deleted when the client receives an error for the ancestor's progeny. Additionally, 204 (No Content) errors SHOULD NOT be returned in the 207 (Multi-Status). The reason for this prohibition is that 204 (No Content) is the default success code.

9.6.2. Example - DELETE

>>Request

```
DELETE /container/ HTTP/1.1
Host: www.example.com
```

>>Response

```
HTTP/1.1 207 Multi-Status
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx
```

```
<?xml version="1.0" encoding="utf-8" ?>
<d:multistatus xmlns:d="DAV:">
  <d:response>
    <d:href>http://www.example.com/container/resource3</d:href>
    <d:status>HTTP/1.1 423 Locked</d:status>
    <d:error><d:lock-token-submitted/></d:error>
  </d:response>
</d:multistatus>
```

In this example, the attempt to delete `http://www.example.com/container/resource3` failed because it is locked, and no lock token was submitted with the request. Consequently, the attempt to delete `http://www.example.com/container/` also failed. Thus, the client knows that the attempt to delete `http://www.example.com/container/` must have also failed since the parent cannot be deleted unless its child has also been deleted. Even though a Depth header has not been included, a depth of infinity is assumed because the method is on a collection.

9.7. PUT Requirements

9.7.1. PUT for Non-Collection Resources

A PUT performed on an existing resource replaces the GET response entity of the resource. Properties defined on the resource may be recomputed during PUT processing but are not otherwise affected. For example, if a server recognizes the content type of the request body, it may be able to automatically extract information that could be profitably exposed as properties.

A PUT that would result in the creation of a resource without an appropriately scoped parent collection MUST fail with a 409 (Conflict).

A PUT request allows a client to indicate what media type an entity body has, and whether it should change if overwritten. Thus, a client SHOULD provide a Content-Type for a new resource if any is known. If the client does not provide a Content-Type for a new resource, the server MAY create a resource with no Content-Type assigned, or it MAY attempt to assign a Content-Type.

Note that although a recipient ought generally to treat metadata supplied with an HTTP request as authoritative, in practice there's no guarantee that a server will accept client-supplied metadata (e.g., any request header beginning with "Content-"). Many servers do not allow configuring the Content-Type on a per-resource basis in the first place. Thus, clients can't always rely on the ability to directly influence the content type by including a Content-Type request header.

9.7.2. PUT for Collections

This specification does not define the behavior of the PUT method for existing collections. A PUT request to an existing collection MAY be treated as an error (405 Method Not Allowed).

The MKCOL method is defined to create collections.

9.8. COPY Method

The COPY method creates a duplicate of the source resource identified by the Request-URI, in the destination resource identified by the URI in the Destination header. The Destination header MUST be present. The exact behavior of the COPY method depends on the type of the source resource.

All WebDAV-compliant resources MUST support the COPY method. However, support for the COPY method does not guarantee the ability to copy a resource. For example, separate programs may control resources on the same server. As a result, it may not be possible to copy a resource to a location that appears to be on the same server.

This method is idempotent, but not safe (see Section 9.1 of [RFC2616]). Responses to this method MUST NOT be cached.

9.8.1. COPY for Non-collection Resources

When the source resource is not a collection, the result of the COPY method is the creation of a new resource at the destination whose state and behavior match that of the source resource as closely as possible. Since the environment at the destination may be different than at the source due to factors outside the scope of control of the server, such as the absence of resources required for correct operation, it may not be possible to completely duplicate the behavior of the resource at the destination. Subsequent alterations to the destination resource will not modify the source resource. Subsequent alterations to the source resource will not modify the destination resource.

9.8.2. COPY for Properties

After a successful COPY invocation, all dead properties on the source resource SHOULD be duplicated on the destination resource. Live properties described in this document SHOULD be duplicated as identically behaving live properties at the destination resource, but not necessarily with the same values. Servers SHOULD NOT convert live properties into dead properties on the destination resource, because clients may then draw incorrect conclusions about the state or functionality of a resource. Note that some live properties are defined such that the absence of the property has a specific meaning (e.g., a flag with one meaning if present, and the opposite if absent), and in these cases, a successful COPY might result in the property being reported as "Not Found" in subsequent requests.

When the destination is an unmapped URL, a COPY operation creates a new resource much like a PUT operation does. Live properties that are related to resource creation (such as DAV:creationdate) should have their values set accordingly.

9.8.3. COPY for Collections

The COPY method on a collection without a Depth header MUST act as if a Depth header with value "infinity" was included. A client may submit a Depth header on a COPY on a collection with a value of "0" or "infinity". Servers MUST support the "0" and "infinity" Depth header behaviors on WebDAV-compliant resources.

An infinite-depth COPY instructs that the collection resource identified by the Request-URI is to be copied to the location identified by the URI in the Destination header, and all its internal member resources are to be copied to a location relative to it, recursively through all levels of the collection hierarchy. Note that an infinite-depth COPY of /A/ into /A/B/ could lead to infinite recursion if not handled correctly.

A COPY of "Depth: 0" only instructs that the collection and its properties, but not resources identified by its internal member URLs, are to be copied.

Any headers included with a COPY MUST be applied in processing every resource to be copied with the exception of the Destination header.

The Destination header only specifies the destination URI for the Request-URI. When applied to members of the collection identified by the Request-URI, the value of Destination is to be modified to reflect the current location in the hierarchy. So, if the Request-URI is /a/ with Host header value http://example.com/ and the

Destination is `http://example.com/b/`, then when `http://example.com/a/c/d` is processed, it must use a Destination of `http://example.com/b/c/d`.

When the COPY method has completed processing, it MUST have created a consistent URL namespace at the destination (see Section 5.1 for the definition of namespace consistency). However, if an error occurs while copying an internal collection, the server MUST NOT copy any resources identified by members of this collection (i.e., the server must skip this subtree), as this would create an inconsistent namespace. After detecting an error, the COPY operation SHOULD try to finish as much of the original copy operation as possible (i.e., the server should still attempt to copy other subtrees and their members that are not descendants of an error-causing collection).

So, for example, if an infinite-depth copy operation is performed on collection `/a/`, which contains collections `/a/b/` and `/a/c/`, and an error occurs copying `/a/b/`, an attempt should still be made to copy `/a/c/`. Similarly, after encountering an error copying a non-collection resource as part of an infinite-depth copy, the server SHOULD try to finish as much of the original copy operation as possible.

If an error in executing the COPY method occurs with a resource other than the resource identified in the Request-URI, then the response MUST be a 207 (Multi-Status), and the URL of the resource causing the failure MUST appear with the specific error.

The 424 (Failed Dependency) status code SHOULD NOT be returned in the 207 (Multi-Status) response from a COPY method. These responses can be safely omitted because the client will know that the progeny of a resource could not be copied when the client receives an error for the parent. Additionally, 201 (Created)/204 (No Content) status codes SHOULD NOT be returned as values in 207 (Multi-Status) responses from COPY methods. They, too, can be safely omitted because they are the default success codes.

9.8.4. COPY and Overwriting Destination Resources

If a COPY request has an Overwrite header with a value of "F", and a resource exists at the Destination URL, the server MUST fail the request.

When a server executes a COPY request and overwrites a destination resource, the exact behavior MAY depend on many factors, including WebDAV extension capabilities (see particularly [RFC3253]). For

example, when an ordinary resource is overwritten, the server could delete the target resource before doing the copy, or could do an in-place overwrite to preserve live properties.

When a collection is overwritten, the membership of the destination collection after the successful COPY request MUST be the same membership as the source collection immediately before the COPY. Thus, merging the membership of the source and destination collections together in the destination is not a compliant behavior.

In general, if clients require the state of the destination URL to be wiped out prior to a COPY (e.g., to force live properties to be reset), then the client could send a DELETE to the destination before the COPY request to ensure this reset.

9.8.5. Status Codes

In addition to the general status codes possible, the following status codes have specific applicability to COPY:

201 (Created) - The source resource was successfully copied. The COPY operation resulted in the creation of a new resource.

204 (No Content) - The source resource was successfully copied to a preexisting destination resource.

207 (Multi-Status) - Multiple resources were to be affected by the COPY, but errors on some of them prevented the operation from taking place. Specific error messages, together with the most appropriate of the source and destination URLs, appear in the body of the multi-status response. For example, if a destination resource was locked and could not be overwritten, then the destination resource URL appears with the 423 (Locked) status.

403 (Forbidden) - The operation is forbidden. A special case for COPY could be that the source and destination resources are the same resource.

409 (Conflict) - A resource cannot be created at the destination until one or more intermediate collections have been created. The server MUST NOT create those intermediate collections automatically.

412 (Precondition Failed) - A precondition header check failed, e.g., the Overwrite header is "F" and the destination URL is already mapped to a resource.

423 (Locked) - The destination resource, or resource within the destination collection, was locked. This response SHOULD contain the 'lock-token-submitted' precondition element.

502 (Bad Gateway) - This may occur when the destination is on another server, repository, or URL namespace. Either the source namespace does not support copying to the destination namespace, or the destination namespace refuses to accept the resource. The client may wish to try GET/PUT and PROPFIND/PROPPATCH instead.

507 (Insufficient Storage) - The destination resource does not have sufficient space to record the state of the resource after the execution of this method.

9.8.6. Example - COPY with Overwrite

This example shows resource `http://www.example.com/~fielding/index.html` being copied to the location `http://www.example.com/users/f/fielding/index.html`. The 204 (No Content) status code indicates that the existing resource at the destination was overwritten.

>>Request

```
COPY /~fielding/index.html HTTP/1.1
Host: www.example.com
Destination: http://www.example.com/users/f/fielding/index.html
```

>>Response

```
HTTP/1.1 204 No Content
```

9.8.7. Example - COPY with No Overwrite

The following example shows the same copy operation being performed, but with the Overwrite header set to "F." A response of 412 (Precondition Failed) is returned because the destination URL is already mapped to a resource.

>>Request

```
COPY /~fielding/index.html HTTP/1.1
Host: www.example.com
Destination: http://www.example.com/users/f/fielding/index.html
Overwrite: F
```

>>Response

HTTP/1.1 412 Precondition Failed

9.8.8. Example - COPY of a Collection

>>Request

COPY /container/ HTTP/1.1
 Host: www.example.com
 Destination: http://www.example.com/othercontainer/
 Depth: infinity

>>Response

HTTP/1.1 207 Multi-Status
 Content-Type: application/xml; charset="utf-8"
 Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>

```
<d:multistatus xmlns:d="DAV:">
  <d:response>
    <d:href>http://www.example.com/othercontainer/R2/</d:href>
    <d:status>HTTP/1.1 423 Locked</d:status>
    <d:error><d:lock-token-submitted/></d:error>
  </d:response>
</d:multistatus>
```

The Depth header is unnecessary as the default behavior of COPY on a collection is to act as if a "Depth: infinity" header had been submitted. In this example, most of the resources, along with the collection, were copied successfully. However, the collection R2 failed because the destination R2 is locked. Because there was an error copying R2, none of R2's members were copied. However, no errors were listed for those members due to the error minimization rules.

9.9. MOVE Method

The MOVE operation on a non-collection resource is the logical equivalent of a copy (COPY), followed by consistency maintenance processing, followed by a delete of the source, where all three actions are performed in a single operation. The consistency maintenance step allows the server to perform updates caused by the move, such as updating all URLs, other than the Request-URI that identifies the source resource, to point to the new destination resource.

The Destination header MUST be present on all MOVE methods and MUST follow all COPY requirements for the COPY part of the MOVE method. All WebDAV-compliant resources MUST support the MOVE method.

Support for the MOVE method does not guarantee the ability to move a resource to a particular destination. For example, separate programs may actually control different sets of resources on the same server. Therefore, it may not be possible to move a resource within a namespace that appears to belong to the same server.

If a resource exists at the destination, the destination resource will be deleted as a side-effect of the MOVE operation, subject to the restrictions of the Overwrite header.

This method is idempotent, but not safe (see Section 9.1 of [RFC2616]). Responses to this method MUST NOT be cached.

9.9.1. MOVE for Properties

Live properties described in this document SHOULD be moved along with the resource, such that the resource has identically behaving live properties at the destination resource, but not necessarily with the same values. Note that some live properties are defined such that the absence of the property has a specific meaning (e.g., a flag with one meaning if present, and the opposite if absent), and in these cases, a successful MOVE might result in the property being reported as "Not Found" in subsequent requests. If the live properties will not work the same way at the destination, the server MAY fail the request.

MOVE is frequently used by clients to rename a file without changing its parent collection, so it's not appropriate to reset all live properties that are set at resource creation. For example, the DAV:creationdate property value SHOULD remain the same after a MOVE.

Dead properties MUST be moved along with the resource.

9.9.2. MOVE for Collections

A MOVE with "Depth: infinity" instructs that the collection identified by the Request-URI be moved to the address specified in the Destination header, and all resources identified by its internal member URLs are to be moved to locations relative to it, recursively through all levels of the collection hierarchy.

The MOVE method on a collection MUST act as if a "Depth: infinity" header was used on it. A client MUST NOT submit a Depth header on a MOVE on a collection with any value but "infinity".

Any headers included with MOVE MUST be applied in processing every resource to be moved with the exception of the Destination header. The behavior of the Destination header is the same as given for COPY on collections.

When the MOVE method has completed processing, it MUST have created a consistent URL namespace at both the source and destination (see Section 5.1 for the definition of namespace consistency). However, if an error occurs while moving an internal collection, the server MUST NOT move any resources identified by members of the failed collection (i.e., the server must skip the error-causing subtree), as this would create an inconsistent namespace. In this case, after detecting the error, the move operation SHOULD try to finish as much of the original move as possible (i.e., the server should still attempt to move other subtrees and the resources identified by their members that are not descendants of an error-causing collection). So, for example, if an infinite-depth move is performed on collection /a/, which contains collections /a/b/ and /a/c/, and an error occurs moving /a/b/, an attempt should still be made to try moving /a/c/. Similarly, after encountering an error moving a non-collection resource as part of an infinite-depth move, the server SHOULD try to finish as much of the original move operation as possible.

If an error occurs with a resource other than the resource identified in the Request-URI, then the response MUST be a 207 (Multi-Status), and the errored resource's URL MUST appear with the specific error.

The 424 (Failed Dependency) status code SHOULD NOT be returned in the 207 (Multi-Status) response from a MOVE method. These errors can be safely omitted because the client will know that the progeny of a resource could not be moved when the client receives an error for the parent. Additionally, 201 (Created)/204 (No Content) responses SHOULD NOT be returned as values in 207 (Multi-Status) responses from a MOVE. These responses can be safely omitted because they are the default success codes.

9.9.3. MOVE and the Overwrite Header

If a resource exists at the destination and the Overwrite header is "T", then prior to performing the move, the server MUST perform a DELETE with "Depth: infinity" on the destination resource. If the Overwrite header is set to "F", then the operation will fail.

9.9.4. Status Codes

In addition to the general status codes possible, the following status codes have specific applicability to MOVE:

201 (Created) - The source resource was successfully moved, and a new URL mapping was created at the destination.

204 (No Content) - The source resource was successfully moved to a URL that was already mapped.

207 (Multi-Status) - Multiple resources were to be affected by the MOVE, but errors on some of them prevented the operation from taking place. Specific error messages, together with the most appropriate of the source and destination URLs, appear in the body of the multi-status response. For example, if a source resource was locked and could not be moved, then the source resource URL appears with the 423 (Locked) status.

403 (Forbidden) - Among many possible reasons for forbidding a MOVE operation, this status code is recommended for use when the source and destination resources are the same.

409 (Conflict) - A resource cannot be created at the destination until one or more intermediate collections have been created. The server MUST NOT create those intermediate collections automatically. Or, the server was unable to preserve the behavior of the live properties and still move the resource to the destination (see 'preserved-live-properties' precondition).

412 (Precondition Failed) - A condition header failed. Specific to MOVE, this could mean that the Overwrite header is "F" and the destination URL is already mapped to a resource.

423 (Locked) - The source or the destination resource, the source or destination resource parent, or some resource within the source or destination collection, was locked. This response SHOULD contain the 'lock-token-submitted' precondition element.

502 (Bad Gateway) - This may occur when the destination is on another server and the destination server refuses to accept the resource. This could also occur when the destination is on another sub-section of the same server namespace.

9.9.5. Example - MOVE of a Non-Collection

This example shows resource `http://www.example.com/~fielding/index.html` being moved to the location `http://www.example.com/users/f/fielding/index.html`. The contents of the destination resource would have been overwritten if the destination URL was already mapped to a resource. In this case, since there was nothing at the destination resource, the response code is 201 (Created).

>>Request

```
MOVE /~fielding/index.html HTTP/1.1
Host: www.example.com
Destination: http://www.example.com/users/f/fielding/index.html
```

>>Response

```
HTTP/1.1 201 Created
Location: http://www.example.com/users/f/fielding/index.html
```

9.9.6. Example - MOVE of a Collection

>>Request

```
MOVE /container/ HTTP/1.1
Host: www.example.com
Destination: http://www.example.com/othercontainer/
Overwrite: F
If: (<urn:uuid:fe184f2e-6eec-41d0-c765-01adc56e6bb4>)
    (<urn:uuid:e454f3f3-acdc-452a-56c7-00a5c91e4b77>)
```

>>Response

```
HTTP/1.1 207 Multi-Status
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<d:multistatus xmlns:d='DAV:'>
  <d:response>
    <d:href>http://www.example.com/othercontainer/C2/</d:href>
    <d:status>HTTP/1.1 423 Locked</d:status>
    <d:error><d:lock-token-submitted/></d:error>
  </d:response>
</d:multistatus>
```

In this example, the client has submitted a number of lock tokens with the request. A lock token will need to be submitted for every resource, both source and destination, anywhere in the scope of the method, that is locked. In this case, the proper lock token was not submitted for the destination

`http://www.example.com/othercontainer/C2/`. This means that the resource `/container/C2/` could not be moved. Because there was an error moving `/container/C2/`, none of `/container/C2/`'s members were moved. However, no errors were listed for those members due to the error minimization rules. User agent authentication has previously occurred via a mechanism outside the scope of the HTTP protocol, in an underlying transport layer.

9.10. LOCK Method

The following sections describe the LOCK method, which is used to take out a lock of any access type and to refresh an existing lock. These sections on the LOCK method describe only those semantics that are specific to the LOCK method and are independent of the access type of the lock being requested.

Any resource that supports the LOCK method MUST, at minimum, support the XML request and response formats defined herein.

This method is neither idempotent nor safe (see Section 9.1 of [RFC2616]). Responses to this method MUST NOT be cached.

9.10.1. Creating a Lock on an Existing Resource

A LOCK request to an existing resource will create a lock on the resource identified by the Request-URI, provided the resource is not already locked with a conflicting lock. The resource identified in the Request-URI becomes the root of the lock. LOCK method requests to create a new lock MUST have an XML request body. The server MUST preserve the information provided by the client in the 'owner' element in the LOCK request. The LOCK request MAY have a Timeout header.

When a new lock is created, the LOCK response:

- o MUST contain a body with the value of the `DAV:lockdiscovery` property in a prop XML element. This MUST contain the full information about the lock just granted, while information about other (shared) locks is OPTIONAL.
- o MUST include the Lock-Token response header with the token associated with the new lock.

9.10.2. Refreshing Locks

A lock is refreshed by sending a LOCK request to the URL of a resource within the scope of the lock. This request MUST NOT have a body and it MUST specify which lock to refresh by using the 'If' header with a single lock token (only one lock may be refreshed at a time). The request MAY contain a Timeout header, which a server MAY accept to change the duration remaining on the lock to the new value. A server MUST ignore the Depth header on a LOCK refresh.

If the resource has other (shared) locks, those locks are unaffected by a lock refresh. Additionally, those locks do not prevent the named lock from being refreshed.

The Lock-Token header is not returned in the response for a successful refresh LOCK request, but the LOCK response body MUST contain the new value for the DAV:lockdiscovery property.

9.10.3. Depth and Locking

The Depth header may be used with the LOCK method. Values other than 0 or infinity MUST NOT be used with the Depth header on a LOCK method. All resources that support the LOCK method MUST support the Depth header.

A Depth header of value 0 means to just lock the resource specified by the Request-URI.

If the Depth header is set to infinity, then the resource specified in the Request-URI along with all its members, all the way down the hierarchy, are to be locked. A successful result MUST return a single lock token. Similarly, if an UNLOCK is successfully executed on this token, all associated resources are unlocked. Hence, partial success is not an option for LOCK or UNLOCK. Either the entire hierarchy is locked or no resources are locked.

If the lock cannot be granted to all resources, the server MUST return a Multi-Status response with a 'response' element for at least one resource that prevented the lock from being granted, along with a suitable status code for that failure (e.g., 403 (Forbidden) or 423 (Locked)). Additionally, if the resource causing the failure was not the resource requested, then the server SHOULD include a 'response' element for the Request-URI as well, with a 'status' element containing 424 Failed Dependency.

If no Depth header is submitted on a LOCK request, then the request MUST act as if a "Depth:infinity" had been submitted.

9.10.4. Locking Unmapped URLs

A successful LOCK method MUST result in the creation of an empty resource that is locked (and that is not a collection) when a resource did not previously exist at that URL. Later on, the lock may go away but the empty resource remains. Empty resources MUST then appear in PROPFIND responses including that URL in the response scope. A server MUST respond successfully to a GET request to an empty resource, either by using a 204 No Content response, or by using 200 OK with a Content-Length header indicating zero length

9.10.5. Lock Compatibility Table

The table below describes the behavior that occurs when a lock request is made on a resource.

Current State	Shared Lock OK	Exclusive Lock OK
None	True	True
Shared Lock	True	False
Exclusive Lock	False	False*

Legend: True = lock may be granted. False = lock MUST NOT be granted. *=It is illegal for a principal to request the same lock twice.

The current lock state of a resource is given in the leftmost column, and lock requests are listed in the first row. The intersection of a row and column gives the result of a lock request. For example, if a shared lock is held on a resource, and an exclusive lock is requested, the table entry is "false", indicating that the lock must not be granted.

9.10.6. LOCK Responses

In addition to the general status codes possible, the following status codes have specific applicability to LOCK:

200 (OK) - The LOCK request succeeded and the value of the DAV:lockdiscovery property is included in the response body.

201 (Created) - The LOCK request was to an unmapped URL, the request succeeded and resulted in the creation of a new resource, and the value of the DAV:lockdiscovery property is included in the response body.

409 (Conflict) - A resource cannot be created at the destination until one or more intermediate collections have been created. The server MUST NOT create those intermediate collections automatically.

423 (Locked), potentially with 'no-conflicting-lock' precondition code - There is already a lock on the resource that is not compatible with the requested lock (see lock compatibility table above).

412 (Precondition Failed), with 'lock-token-matches-request-uri' precondition code - The LOCK request was made with an If header, indicating that the client wishes to refresh the given lock. However, the Request-URI did not fall within the scope of the lock identified by the token. The lock may have a scope that does not include the Request-URI, or the lock could have disappeared, or the token may be invalid.

9.10.7. Example - Simple Lock Request

>>Request

```
LOCK /workspace/webdav/proposal.doc HTTP/1.1
Host: example.com
Timeout: Infinite, Second=4100000000
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx
Authorization: Digest username="ejw",
    realm="ejw@example.com", nonce="...",
    uri="/workspace/webdav/proposal.doc",
    response="...", opaque="..."

<?xml version="1.0" encoding="utf-8" ?>
<D:lockinfo xmlns:D='DAV:'>
  <D:lockscope><D:exclusive/></D:lockscope>
  <D:locktype><D:write/></D:locktype>
  <D:owner>
    <D:href>http://example.org/~ejw/contact.html</D:href>
  </D:owner>
</D:lockinfo>
```

>>Response

```
HTTP/1.1 200 OK
Lock-Token: <urn:uuid:e71d4fae-5dec-22d6-fea5-00a0c91e6be4>
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<D:prop xmlns:D="DAV:">
```



```

<D:lockdiscovery>
  <D:activelock>
    <D:locktype><D:write/></D:locktype>
    <D:lockscope><D:exclusive/></D:lockscope>
    <D:depth>infinity</D:depth>
    <D:owner>
      <D:href>http://example.org/~ejw/contact.html</D:href>
    </D:owner>
    <D:timeout>Second-604800</D:timeout>
    <D:locktoken>
      <D:href>
        >urn:uuid:e71d4fae-5dec-22d6-fea5-00a0c91e6be4</D:href>
      </D:locktoken>
    <D:lockroot>
      <D:href>
        >http://example.com/workspace/webdav/proposal.doc</D:href>
      </D:lockroot>
    </D:activelock>
  </D:lockdiscovery>
</D:prop>

```

This example shows the successful creation of an exclusive write lock on resource `http://example.com/workspace/webdav/proposal.doc`. The resource `http://example.org/~ejw/contact.html` contains contact information for the creator of the lock. The server has an activity-based timeout policy in place on this resource, which causes the lock to automatically be removed after 1 week (604800 seconds). Note that the nonce, response, and opaque fields have not been calculated in the Authorization request header.

9.10.8. Example - Refreshing a Write Lock

>>Request

```

LOCK /workspace/webdav/proposal.doc HTTP/1.1
Host: example.com
Timeout: Infinite, Second-4100000000
If: (<urn:uuid:e71d4fae-5dec-22d6-fea5-00a0c91e6be4>)
Authorization: Digest username="ejw",
  realm="ejw@example.com", nonce="...",
  uri="/workspace/webdav/proposal.doc",
  response="...", opaque="..."

```

>>Response

```

HTTP/1.1 200 OK
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<D:prop xmlns:D="DAV:">
  <D:lockdiscovery>
    <D:activelock>
      <D:locktype><D:write/></D:locktype>
      <D:lockscope><D:exclusive/></D:lockscope>
      <D:depth>infinity</D:depth>
      <D:owner>
        <D:href>http://example.org/~ejw/contact.html</D:href>
      </D:owner>
      <D:timeout>Second-604800</D:timeout>
      <D:locktoken>
        <D:href>
          >urn:uuid:e71d4fae-5dec-22d6-fea5-00a0c91e6be4</D:href>
      </D:locktoken>
      <D:lockroot>
        <D:href>
          >http://example.com/workspace/webdav/proposal.doc</D:href>
      </D:lockroot>
    </D:activelock>
  </D:lockdiscovery>
</D:prop>

```

This request would refresh the lock, attempting to reset the timeout to the new value specified in the timeout header. Notice that the client asked for an infinite time out but the server choose to ignore the request. In this example, the nonce, response, and opaque fields have not been calculated in the Authorization request header.

9.10.9. Example - Multi-Resource Lock Request

>>Request

```

LOCK /webdav/ HTTP/1.1
Host: example.com
Timeout: Infinite, Second-4100000000
Depth: infinity
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx
Authorization: Digest username="ejw",
  realm="ejw@example.com", nonce="..."

```

```
uri="/workspace/webdav/proposal.doc",
response="...", opaque="..."
```

```
<?xml version="1.0" encoding="utf-8" ?>
<D:lockinfo xmlns:D="DAV:">
  <D:locktype><D:write/></D:locktype>
  <D:lockscope><D:exclusive/></D:lockscope>
  <D:owner>
    <D:href>http://example.org/~ejw/contact.html</D:href>
  </D:owner>
</D:lockinfo>
```

>>Response

```
HTTP/1.1 207 Multi-Status
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx
```

```
<?xml version="1.0" encoding="utf-8" ?>
<D:multistatus xmlns:D="DAV:">
  <D:response>
    <D:href>http://example.com/webdav/secret</D:href>
    <D:status>HTTP/1.1 403 Forbidden</D:status>
  </D:response>
  <D:response>
    <D:href>http://example.com/webdav/</D:href>
    <D:status>HTTP/1.1 424 Failed Dependency</D:status>
  </D:response>
</D:multistatus>
```

This example shows a request for an exclusive write lock on a collection and all its children. In this request, the client has specified that it desires an infinite-length lock, if available, otherwise a timeout of 4.1 billion seconds, if available. The request entity body contains the contact information for the principal taking out the lock -- in this case, a Web page URL.

The error is a 403 (Forbidden) response on the resource `http://example.com/webdav/secret`. Because this resource could not be locked, none of the resources were locked. Note also that the a 'response' element for the Request-URI itself has been included as required.

In this example, the nonce, response, and opaque fields have not been calculated in the Authorization request header.

9.11. UNLOCK Method

The UNLOCK method removes the lock identified by the lock token in the Lock-Token request header. The Request-URI MUST identify a resource within the scope of the lock.

Note that use of the Lock-Token header to provide the lock token is not consistent with other state-changing methods, which all require an If header with the lock token. Thus, the If header is not needed to provide the lock token. Naturally, when the If header is present, it has its normal meaning as a conditional header.

For a successful response to this method, the server MUST delete the lock entirely.

If all resources that have been locked under the submitted lock token cannot be unlocked, then the UNLOCK request MUST fail.

A successful response to an UNLOCK method does not mean that the resource is necessarily unlocked. It means that the specific lock corresponding to the specified token no longer exists.

Any DAV-compliant resource that supports the LOCK method MUST support the UNLOCK method.

This method is idempotent, but not safe (see Section 9.1 of [RFC2616]). Responses to this method MUST NOT be cached.

9.11.1. Status Codes

In addition to the general status codes possible, the following status codes have specific applicability to UNLOCK:

204 (No Content) - Normal success response (rather than 200 OK, since 200 OK would imply a response body, and an UNLOCK success response does not normally contain a body).

400 (Bad Request) - No lock token was provided.

403 (Forbidden) - The currently authenticated principal does not have permission to remove the lock.

409 (Conflict), with 'lock-token-matches-request-uri' precondition - The resource was not locked, or the request was made to a Request-URI that was not within the scope of the lock.

9.11.2. Example - UNLOCK

>>Request

```

UNLOCK /workspace/webdav/info.doc HTTP/1.1
Host: example.com
Lock-Token: <urn:uuid:a515cfa4-5da4-22e1-f5b5-00a0451e6bf7>
Authorization: Digest username="ejw"
    realm="ejw@example.com", nonce="...",
    uri="/workspace/webdav/proposal.doc",
    response="...", opaque="..."

```

>>Response

```

HTTP/1.1 204 No Content

```

In this example, the lock identified by the lock token "urn:uuid:a515cfa4-5da4-22e1-f5b5-00a0451e6bf7" is successfully removed from the resource <http://example.com/workspace/webdav/info.doc>. If this lock included more than just one resource, the lock is removed from all resources included in the lock.

In this example, the nonce, response, and opaque fields have not been calculated in the Authorization request header.

10. HTTP Headers for Distributed Authoring

All DAV headers follow the same basic formatting rules as HTTP headers. This includes rules like line continuation and how to combine (or separate) multiple instances of the same header using commas.

WebDAV adds two new conditional headers to the set defined in HTTP: the If and Overwrite headers.

10.1. DAV Header

```

DAV = "DAV" ":" #( compliance-class )
compliance-class = ( "1" | "2" | "3" | extend )
extend = Coded-URL | token
        ; token is defined in RFC 2616, Section 2.2
Coded-URL = "<" absolute-URI ">"
           ; No linear whitespace (LWS) allowed in Coded-URL
           ; absolute-URI defined in RFC 3986, Section 4.3

```

This general-header appearing in the response indicates that the resource supports the DAV schema and protocol as specified. All DAV-compliant resources MUST return the DAV header with compliance-class "1" on all OPTIONS responses. In cases where WebDAV is only supported in part of the server namespace, an OPTIONS request to non-WebDAV resources (including "/") SHOULD NOT advertise WebDAV support.

The value is a comma-separated list of all compliance class identifiers that the resource supports. Class identifiers may be Coded-URLs or tokens (as defined by [RFC2616]). Identifiers can appear in any order. Identifiers that are standardized through the IETF RFC process are tokens, but other identifiers SHOULD be Coded-URLs to encourage uniqueness.

A resource must show class 1 compliance if it shows class 2 or 3 compliance. In general, support for one compliance class does not entail support for any other, and in particular, support for compliance class 3 does not require support for compliance class 2. Please refer to Section 18 for more details on compliance classes defined in this specification.

Note that many WebDAV servers do not advertise WebDAV support in response to "OPTIONS *".

As a request header, this header allows the client to advertise compliance with named features when the server needs that information. Clients SHOULD NOT send this header unless a standards track specification requires it. Any extension that makes use of this as a request header will need to carefully consider caching implications.

10.2. Depth Header

```
Depth = "Depth" ":" ("0" | "1" | "infinity")
```

The Depth request header is used with methods executed on resources that could potentially have internal members to indicate whether the method is to be applied only to the resource ("Depth: 0"), to the resource and its internal members only ("Depth: 1"), or the resource and all its members ("Depth: infinity").

The Depth header is only supported if a method's definition explicitly provides for such support.

The following rules are the default behavior for any method that supports the Depth header. A method may override these defaults by defining different behavior in its definition.

Methods that support the Depth header may choose not to support all of the header's values and may define, on a case-by-case basis, the behavior of the method if a Depth header is not present. For example, the MOVE method only supports "Depth: infinity", and if a Depth header is not present, it will act as if a "Depth: infinity" header had been applied.

Clients MUST NOT rely upon methods executing on members of their hierarchies in any particular order or on the execution being atomic unless the particular method explicitly provides such guarantees.

Upon execution, a method with a Depth header will perform as much of its assigned task as possible and then return a response specifying what it was able to accomplish and what it failed to do.

So, for example, an attempt to COPY a hierarchy may result in some of the members being copied and some not.

By default, the Depth header does not interact with other headers. That is, each header on a request with a Depth header MUST be applied only to the Request-URI if it applies to any resource, unless specific Depth behavior is defined for that header.

If a source or destination resource within the scope of the Depth header is locked in such a way as to prevent the successful execution of the method, then the lock token for that resource MUST be submitted with the request in the If request header.

The Depth header only specifies the behavior of the method with regards to internal members. If a resource does not have internal members, then the Depth header MUST be ignored.

10.3. Destination Header

The Destination request header specifies the URI that identifies a destination resource for methods such as COPY and MOVE, which take two URIs as parameters.

Destination = "Destination" ":" Simple-ref

If the Destination value is an absolute-URI (Section 4.3 of [RFC3986]), it may name a different server (or different port or scheme). If the source server cannot attempt a copy to the remote server, it MUST fail the request. Note that copying and moving resources to remote servers is not fully defined in this specification (e.g., specific error conditions).

If the Destination value is too long or otherwise unacceptable, the server SHOULD return 400 (Bad Request), ideally with helpful information in an error body.

10.4. If Header

The If request header is intended to have similar functionality to the If-Match header defined in Section 14.24 of [RFC2616]. However, the If header handles any state token as well as ETags. A typical example of a state token is a lock token, and lock tokens are the only state tokens defined in this specification.

10.4.1. Purpose

The If header has two distinct purposes:

- o The first purpose is to make a request conditional by supplying a series of state lists with conditions that match tokens and ETags to a specific resource. If this header is evaluated and all state lists fail, then the request MUST fail with a 412 (Precondition Failed) status. On the other hand, the request can succeed only if one of the described state lists succeeds. The success criteria for state lists and matching functions are defined in Sections 10.4.3 and 10.4.4.
- o Additionally, the mere fact that a state token appears in an If header means that it has been "submitted" with the request. In general, this is used to indicate that the client has knowledge of that state token. The semantics for submitting a state token depend on its type (for lock tokens, please refer to Section 6).

Note that these two purposes need to be treated distinctly: a state token counts as being submitted independently of whether the server actually has evaluated the state list it appears in, and also independently of whether or not the condition it expressed was found to be true.

10.4.2. Syntax

```
If = "If" ":" ( 1*No-tag-list | 1*Tagged-list )

No-tag-list = List
Tagged-list = Resource-Tag 1*List

List = "(" 1*Condition ")"
Condition = ["Not"] (State-token | "[" entity-tag ")")
; entity-tag: see Section 3.11 of [RFC2616]
; No LWS allowed between "[", entity-tag and "]"
```


State-token = Coded-URL

Resource-Tag = "<" Simple-ref ">"
; Simple-ref: see Section 8.3
; No LWS allowed in Resource-Tag

The syntax distinguishes between untagged lists ("No-tag-list") and tagged lists ("Tagged-list"). Untagged lists apply to the resource identified by the Request-URI, while tagged lists apply to the resource identified by the preceding Resource-Tag.

A Resource-Tag applies to all subsequent Lists, up to the next Resource-Tag.

Note that the two list types cannot be mixed within an If header. This is not a functional restriction because the No-tag-list syntax is just a shorthand notation for a Tagged-list production with a Resource-Tag referring to the Request-URI.

Each List consists of one or more Conditions. Each Condition is defined in terms of an entity-tag or state-token, potentially negated by the prefix "Not".

Note that the If header syntax does not allow multiple instances of If headers in a single request. However, the HTTP header syntax allows extending single header values across multiple lines, by inserting a line break followed by whitespace (see [RFC2616], Section 4.2).

10.4.3. List Evaluation

A Condition that consists of a single entity-tag or state-token evaluates to true if the resource matches the described state (where the individual matching functions are defined below in Section 10.4.4). Prefixing it with "Not" reverses the result of the evaluation (thus, the "Not" applies only to the subsequent entity-tag or state-token).

Each List production describes a series of conditions. The whole list evaluates to true if and only if each condition evaluates to true (that is, the list represents a logical conjunction of Conditions).

Each No-tag-list and Tagged-list production may contain one or more Lists. They evaluate to true if and only if any of the contained lists evaluates to true (that is, if there's more than one List, that List sequence represents a logical disjunction of the Lists).

Finally, the whole If header evaluates to true if and only if at least one of the No-tag-list or Tagged-list productions evaluates to true. If the header evaluates to false, the server MUST reject the request with a 412 (Precondition Failed) status. Otherwise, execution of the request can proceed as if the header wasn't present.

10.4.4. Matching State Tokens and ETags

When performing If header processing, the definition of a matching state token or entity tag is as follows:

Identifying a resource: The resource is identified by the URI along with the token, in tagged list production, or by the Request-URI in untagged list production.

Matching entity tag: Where the entity tag matches an entity tag associated with the identified resource. Servers MUST use either the weak or the strong comparison function defined in Section 13.3.3 of [RFC2616].

Matching state token: Where there is an exact match between the state token in the If header and any state token on the identified resource. A lock state token is considered to match if the resource is anywhere in the scope of the lock.

Handling unmapped URLs: For both ETags and state tokens, treat as if the URL identified a resource that exists but does not have the specified state.

10.4.5. If Header and Non-DAV-Aware Proxies

Non-DAV-aware proxies will not honor the If header, since they will not understand the If header, and HTTP requires non-understood headers to be ignored. When communicating with HTTP/1.1 proxies, the client MUST use the "Cache-Control: no-cache" request header so as to prevent the proxy from improperly trying to service the request from its cache. When dealing with HTTP/1.0 proxies, the "Pragma: no-cache" request header MUST be used for the same reason.

Because in general clients may not be able to reliably detect non-DAV-aware intermediates, they are advised to always prevent caching using the request directives mentioned above.

10.4.6. Example - No-tag Production

```
If: (<urn:uuid:181d4fae-7d8c-11d0-a765-00a0c91e6bf2>
  ["I am an ETag"])
  (["I am another ETag"])
```

The previous header would require that the resource identified in the Request-URI be locked with the specified lock token and be in the state identified by the "I am an ETag" ETag or in the state identified by the second ETag "I am another ETag".

To put the matter more plainly one can think of the previous If header as expressing the condition below:

```
(
  is-locked-with(urn:uuid:181d4fae-7d8c-11d0-a765-00a0c91e6bf2) AND
  matches-etag("I am an ETag")
)
OR
(
  matches-etag("I am another ETag")
)
```

10.4.7. Example - Using "Not" with No-tag Production

```
If: (Not <urn:uuid:181d4fae-7d8c-11d0-a765-00a0c91e6bf2>
  <urn:uuid:58f202ac-22cf-11d1-b12d-002035b29092>)
```

This If header requires that the resource must not be locked with a lock having the lock token urn:uuid:181d4fae-7d8c-11d0-a765-00a0c91e6bf2 and must be locked by a lock with the lock token urn:uuid:58f202ac-22cf-11d1-b12d-002035b29092.

10.4.8. Example - Causing a Condition to Always Evaluate to True

There may be cases where a client wishes to submit state tokens, but doesn't want the request to fail just because the state token isn't current anymore. One simple way to do this is to include a Condition that is known to always evaluate to true, such as in:

```
If: (<urn:uuid:181d4fae-7d8c-11d0-a765-00a0c91e6bf2>)
  (Not <DAV:no-lock>)
```

"DAV:no-lock" is known to never represent a current lock token. Lock tokens are assigned by the server, following the uniqueness requirements described in Section 6.5, therefore cannot use the "DAV:" scheme. Thus, by applying "Not" to a state token that is

known not to be current, the Condition always evaluates to true. Consequently, the whole If header will always evaluate to true, and the lock token urn:uuid:181d4fae-7d8c-11d0-a765-00a0c91e6bf2 will be submitted in any case.

10.4.9. Example - Tagged List If Header in COPY

>>Request

```
COPY /resource1 HTTP/1.1
Host: www.example.com
Destination: /resource2
If: </resource1>
    (<urn:uuid:181d4fae-7d8c-11d0-a765-00a0c91e6bf2>
    [W/"A weak ETag"]) (["strong ETag"])
```

In this example, `http://www.example.com/resource1` is being copied to `http://www.example.com/resource2`. When the method is first applied to `http://www.example.com/resource1`, resource1 must be in the state specified by "`<urn:uuid:181d4fae-7d8c-11d0-a765-00a0c91e6bf2> [W/"A weak ETag"] (["strong ETag"]`". That is, either it must be locked with a lock token of "urn:uuid:181d4fae-7d8c-11d0-a765-00a0c91e6bf2" and have a weak entity tag `W/"A weak ETag"` or it must have a strong entity tag `"strong ETag"`.

10.4.10. Example - Matching Lock Tokens with Collection Locks

```
DELETE /specs/rfc2518.txt HTTP/1.1
Host: www.example.com
If: <http://www.example.com/specs/>
    (<urn:uuid:181d4fae-7d8c-11d0-a765-00a0c91e6bf2>)
```

For this example, the lock token must be compared to the identified resource, which is the 'specs' collection identified by the URL in the tagged list production. If the 'specs' collection is not locked by a lock with the specified lock token, the request MUST fail. Otherwise, this request could succeed, because the If header evaluates to true, and because the lock token for the lock affecting the affected resource has been submitted.

10.4.11. Example - Matching ETags on Unmapped URLs

Consider a collection `"/specs"` that does not contain the member `"/specs/rfc2518.doc"`. In this case, the If header

```
If: </specs/rfc2518.doc> (["4217"])
```

will evaluate to false (the URI isn't mapped, thus the resource identified by the URI doesn't have an entity matching the ETag "4217").

On the other hand, an If header of

```
If: </specs/rfc2518.doc> (Not ["4217"])
```

will consequently evaluate to true.

Note that, as defined above in Section 10.4.4, the same considerations apply to matching state tokens.

10.5. Lock-Token Header

```
Lock-Token = "Lock-Token" ":" Coded-URL
```

The Lock-Token request header is used with the UNLOCK method to identify the lock to be removed. The lock token in the Lock-Token request header MUST identify a lock that contains the resource identified by Request-URI as a member.

The Lock-Token response header is used with the LOCK method to indicate the lock token created as a result of a successful LOCK request to create a new lock.

10.6. Overwrite Header

```
Overwrite = "Overwrite" ":" ("T" | "F")
```

The Overwrite request header specifies whether the server should overwrite a resource mapped to the destination URL during a COPY or MOVE. A value of "F" states that the server must not perform the COPY or MOVE operation if the destination URL does map to a resource. If the overwrite header is not included in a COPY or MOVE request, then the resource MUST treat the request as if it has an overwrite header of value "T". While the Overwrite header appears to duplicate the functionality of using an "If-Match: *" header (see [RFC2616]), If-Match applies only to the Request-URI, and not to the Destination of a COPY or MOVE.

If a COPY or MOVE is not performed due to the value of the Overwrite header, the method MUST fail with a 412 (Precondition Failed) status code. The server MUST do authorization checks before checking this or any conditional header.

All DAV-compliant resources MUST support the Overwrite header.

10.7. Timeout Request Header

```
TimeOut = "Timeout" ":" 1#TimeType
TimeType = ("Second-" DAVTimeOutVal | "Infinite")
           ; No LWS allowed within TimeType
DAVTimeOutVal = 1*DIGIT
```

Clients MAY include Timeout request headers in their LOCK requests. However, the server is not required to honor or even consider these requests. Clients MUST NOT submit a Timeout request header with any method other than a LOCK method.

The "Second" TimeType specifies the number of seconds that will elapse between granting of the lock at the server, and the automatic removal of the lock. The timeout value for TimeType "Second" MUST NOT be greater than $2^{32}-1$.

See Section 6.6 for a description of lock timeout behavior.

11. Status Code Extensions to HTTP/1.1

The following status codes are added to those defined in HTTP/1.1 [RFC2616].

11.1. 207 Multi-Status

The 207 (Multi-Status) status code provides status for multiple independent operations (see Section 13 for more information).

11.2. 422 Unprocessable Entity

The 422 (Unprocessable Entity) status code means the server understands the content type of the request entity (hence a 415(Unsupported Media Type) status code is inappropriate), and the syntax of the request entity is correct (thus a 400 (Bad Request) status code is inappropriate) but was unable to process the contained instructions. For example, this error condition may occur if an XML request body contains well-formed (i.e., syntactically correct), but semantically erroneous, XML instructions.

11.3. 423 Locked

The 423 (Locked) status code means the source or destination resource of a method is locked. This response SHOULD contain an appropriate precondition or postcondition code, such as 'lock-token-submitted' or 'no-conflicting-lock'.

11.4. 424 Failed Dependency

The 424 (Failed Dependency) status code means that the method could not be performed on the resource because the requested action depended on another action and that action failed. For example, if a command in a PROPPATCH method fails, then, at minimum, the rest of the commands will also fail with 424 (Failed Dependency).

11.5. 507 Insufficient Storage

The 507 (Insufficient Storage) status code means the method could not be performed on the resource because the server is unable to store the representation needed to successfully complete the request. This condition is considered to be temporary. If the request that received this status code was the result of a user action, the request **MUST NOT** be repeated until it is requested by a separate user action.

12. Use of HTTP Status Codes

These HTTP codes are not redefined, but their use is somewhat extended by WebDAV methods and requirements. In general, many HTTP status codes can be used in response to any request, not just in cases described in this document. Note also that WebDAV servers are known to use 300-level redirect responses (and early interoperability tests found clients unprepared to see those responses). A 300-level response **MUST NOT** be used when the server has created a new resource in response to the request.

12.1. 412 Precondition Failed

Any request can contain a conditional header defined in HTTP (If-Match, If-Modified-Since, etc.) or the "If" or "Overwrite" conditional headers defined in this specification. If the server evaluates a conditional header, and if that condition fails to hold, then this error code **MUST** be returned. On the other hand, if the client did not include a conditional header in the request, then the server **MUST NOT** use this status code.

12.2. 414 Request-URI Too Long

This status code is used in HTTP 1.1 only for Request-URIs, not URIs in other locations.

13. Multi-Status Response

A Multi-Status response conveys information about multiple resources in situations where multiple status codes might be appropriate. The default Multi-Status response body is a text/xml or application/xml HTTP entity with a 'multistatus' root element. Further elements contain 200, 300, 400, and 500 series status codes generated during the method invocation. 100 series status codes SHOULD NOT be recorded in a 'response' XML element.

Although '207' is used as the overall response status code, the recipient needs to consult the contents of the multistatus response body for further information about the success or failure of the method execution. The response MAY be used in success, partial success and also in failure situations.

The 'multistatus' root element holds zero or more 'response' elements in any order, each with information about an individual resource. Each 'response' element MUST have an 'href' element to identify the resource.

A Multi-Status response uses one out of two distinct formats for representing the status:

1. A 'status' element as child of the 'response' element indicates the status of the message execution for the identified resource as a whole (for instance, see Section 9.6.2). Some method definitions provide information about specific status codes clients should be prepared to see in a response. However, clients MUST be able to handle other status codes, using the generic rules defined in Section 10 of [RFC2616].
2. For PROPFIND and PROPPATCH, the format has been extended using the 'propstat' element instead of 'status', providing information about individual properties of a resource. This format is specific to PROPFIND and PROPPATCH, and is described in detail in Sections 9.1 and 9.2.

13.1. Response Headers

HTTP defines the Location header to indicate a preferred URL for the resource that was addressed in the Request-URI (e.g., in response to successful PUT requests or in redirect responses). However, use of this header creates ambiguity when there are URLs in the body of the response, as with Multi-Status. Thus, use of the Location header with the Multi-Status response is intentionally undefined.

13.2. Handling Redirected Child Resources

Redirect responses (300-303, 305, and 307) defined in HTTP 1.1 normally take a Location header to indicate the new URI for the single resource redirected from the Request-URI. Multi-Status responses contain many resource addresses, but the original definition in [RFC2518] did not have any place for the server to provide the new URI for redirected resources. This specification does define a 'location' element for this information (see Section 14.9). Servers MUST use this new element with redirect responses in Multi-Status.

Clients encountering redirected resources in Multi-Status MUST NOT rely on the 'location' element being present with a new URI. If the element is not present, the client MAY reissue the request to the individual redirected resource, because the response to that request can be redirected with a Location header containing the new URI.

13.3. Internal Status Codes

Sections 9.2.1, 9.1.2, 9.6.1, 9.8.3, and 9.9.2 define various status codes used in Multi-Status responses. This specification does not define the meaning of other status codes that could appear in these responses.

14. XML Element Definitions

In this section, the final line of each section gives the element type declaration using the format defined in [REC-XML]. The "Value" field, where present, specifies further restrictions on the allowable contents of the XML element using BNF (i.e., to further restrict the values of a PCDATA element). Note that all of the elements defined here may be extended according to the rules defined in Section 17. All elements defined here are in the "DAV:" namespace.

14.1. activelock XML Element

Name: activelock

Purpose: Describes a lock on a resource.

```
<!ELEMENT activelock (lockscope, locktype, depth, owner?, timeout?,  
locktoken?, lockroot)>
```

14.2. allprop XML Element

Name: allprop

Purpose: Specifies that all names and values of dead properties and the live properties defined by this document existing on the resource are to be returned.

<!ELEMENT allprop EMPTY >

14.3. collection XML Element

Name: collection

Purpose: Identifies the associated resource as a collection. The DAV:resourcetype property of a collection resource MUST contain this element. It is normally empty but extensions may add sub-elements.

<!ELEMENT collection EMPTY >

14.4. depth XML Element

Name: depth

Purpose: Used for representing depth values in XML content (e.g., in lock information).

Value: "0" | "1" | "infinity"

<!ELEMENT depth (#PCDATA) >

14.5. error XML Element

Name: error

Purpose: Error responses, particularly 403 Forbidden and 409 Conflict, sometimes need more information to indicate what went wrong. In these cases, servers MAY return an XML response body with a document element of 'error', containing child elements identifying particular condition codes.

Description: Contains at least one XML element, and MUST NOT contain text or mixed content. Any element that is a child of the 'error' element is considered to be a precondition or postcondition code. Unrecognized elements MUST be ignored.

<!ELEMENT error ANY >

14.6. exclusive XML Element

Name: exclusive

Purpose: Specifies an exclusive lock.

```
<!ELEMENT exclusive EMPTY >
```

14.7. href XML Element

Name: href

Purpose: MUST contain a URI or a relative reference.

Description: There may be limits on the value of 'href' depending on the context of its use. Refer to the specification text where 'href' is used to see what limitations apply in each case.

Value: Simple-ref

```
<!ELEMENT href (#PCDATA)>
```

14.8. include XML Element

Name: include

Purpose: Any child element represents the name of a property to be included in the PROPFIND response. All elements inside an 'include' XML element MUST define properties related to the resource, although possible property names are in no way limited to those property names defined in this document or other standards. This element MUST NOT contain text or mixed content.

```
<!ELEMENT include ANY >
```

14.9. location XML Element

Name: location

Purpose: HTTP defines the "Location" header (see [RFC2616], Section 14.30) for use with some status codes (such as 201 and the 300 series codes). When these codes are used inside a 'multistatus' element, the 'location' element can be used to provide the accompanying Location header value.

Description: Contains a single href element with the same value that would be used in a Location header.

```
<!ELEMENT location (href)>
```

14.10. lockentry XML Element

Name: lockentry

Purpose: Defines the types of locks that can be used with the resource.

```
<!ELEMENT lockentry (lockscope, locktype) >
```

14.11. lockinfo XML Element

Name: lockinfo

Purpose: The 'lockinfo' XML element is used with a LOCK method to specify the type of lock the client wishes to have created.

```
<!ELEMENT lockinfo (lockscope, locktype, owner?) >
```

14.12. lockroot XML Element

Name: lockroot

Purpose: Contains the root URL of the lock, which is the URL through which the resource was addressed in the LOCK request.

Description: The href element contains the root of the lock. The server SHOULD include this in all DAV:lockdiscovery property values and the response to LOCK requests.

```
<!ELEMENT lockroot (href) >
```

14.13. lockscope XML Element

Name: lockscope

Purpose: Specifies whether a lock is an exclusive lock, or a shared lock.

```
<!ELEMENT lockscope (exclusive | shared) >
```

14.14. locktoken XML Element

Name: locktoken

Purpose: The lock token associated with a lock.

Description: The href contains a single lock token URI, which refers to the lock.

```
<!ELEMENT locktoken (href) >
```

14.15. locktype XML Element

Name: locktype

Purpose: Specifies the access type of a lock. At present, this specification only defines one lock type, the write lock.

```
<!ELEMENT locktype (write) >
```

14.16. multistatus XML Element

Name: multistatus

Purpose: Contains multiple response messages.

Description: The 'responsedescription' element at the top level is used to provide a general message describing the overarching nature of the response. If this value is available, an application may use it instead of presenting the individual response descriptions contained within the responses.

```
<!ELEMENT multistatus (response*, responsedescription?) >
```

14.17. owner XML Element

Name: owner

Purpose: Holds client-supplied information about the creator of a lock.

Description: Allows a client to provide information sufficient for either directly contacting a principal (such as a telephone number or Email URI), or for discovering the principal (such as the URL

of a homepage) who created a lock. The value provided MUST be treated as a dead property in terms of XML Information Item preservation. The server MUST NOT alter the value unless the owner value provided by the client is empty. For a certain amount of interoperability between different client implementations, if clients have URI-formatted contact information for the lock creator suitable for user display, then clients SHOULD put those URIs in 'href' child elements of the 'owner' element.

Extensibility: MAY be extended with child elements, mixed content, text content or attributes.

<!ELEMENT owner ANY >

14.18. prop XML Element

Name: prop

Purpose: Contains properties related to a resource.

Description: A generic container for properties defined on resources. All elements inside a 'prop' XML element MUST define properties related to the resource, although possible property names are in no way limited to those property names defined in this document or other standards. This element MUST NOT contain text or mixed content.

<!ELEMENT prop ANY >

14.19. propertyupdate XML Element

Name: propertyupdate

Purpose: Contains a request to alter the properties on a resource.

Description: This XML element is a container for the information required to modify the properties on the resource.

<!ELEMENT propertyupdate (remove | set)+ >

14.20. propfind XML Element

Name: propfind

Purpose: Specifies the properties to be returned from a PROPFIND method. Four special elements are specified for use with 'propfind': 'prop', 'allprop', 'include', and 'propname'. If 'prop' is used inside 'propfind', it MUST NOT contain property values.

```
<!ELEMENT propfind ( propname | (allprop, include?) | prop ) >
```

14.21. propname XML Element

Name: propname

Purpose: Specifies that only a list of property names on the resource is to be returned.

```
<!ELEMENT propname EMPTY >
```

14.22. propstat XML Element

Name: propstat

Purpose: Groups together a prop and status element that is associated with a particular 'href' element.

Description: The propstat XML element MUST contain one prop XML element and one status XML element. The contents of the prop XML element MUST only list the names of properties to which the result in the status element applies. The optional precondition/postcondition element and 'responsedescription' text also apply to the properties named in 'prop'.

```
<!ELEMENT propstat (prop, status, error?, responsedescription?) >
```

14.23. remove XML Element

Name: remove

Purpose: Lists the properties to be removed from a resource.

Description: Remove instructs that the properties specified in prop should be removed. Specifying the removal of a property that does not exist is not an error. All the XML elements in a 'prop' XML element inside of a 'remove' XML element MUST be empty, as only the names of properties to be removed are required.

```
<!ELEMENT remove (prop) >
```

14.24. response XML Element

Name: response

Purpose: Holds a single response describing the effect of a method on resource and/or its properties.

Description: The 'href' element contains an HTTP URL pointing to a WebDAV resource when used in the 'response' container. A particular 'href' value MUST NOT appear more than once as the child of a 'response' XML element under a 'multistatus' XML element. This requirement is necessary in order to keep processing costs for a response to linear time. Essentially, this prevents having to search in order to group together all the responses by 'href'. There are, however, no requirements regarding ordering based on 'href' values. The optional precondition/postcondition element and 'responsedescription' text can provide additional information about this resource relative to the request or result.

```
<!ELEMENT response (href, ((href*, status)|(propstat+)),  
                        error?, responsedescription? , location?) >
```

14.25. responsedescription XML Element

Name: responsedescription

Purpose: Contains information about a status response within a Multi-Status.

Description: Provides information suitable to be presented to a user.

```
<!ELEMENT responsedescription (#PCDATA) >
```

14.26. set XML Element

Name: set

Purpose: Lists the property values to be set for a resource.

Description: The 'set' element MUST contain only a 'prop' element. The elements contained by the 'prop' element inside the 'set' element MUST specify the name and value of properties that are set on the resource identified by Request-URI. If a property already exists, then its value is replaced. Language tagging information appearing in the scope of the 'prop' element (in the "xml:lang"

attribute, if present) MUST be persistently stored along with the property, and MUST be subsequently retrievable using PROPFIND.

```
<!ELEMENT set (prop) >
```

14.27. shared XML Element

Name: shared

Purpose: Specifies a shared lock.

```
<!ELEMENT shared EMPTY >
```

14.28. status XML Element

Name: status

Purpose: Holds a single HTTP status-line.

Value: status-line (defined in Section 6.1 of [RFC2616])

```
<!ELEMENT status (#PCDATA) >
```

14.29. timeout XML Element

Name: timeout

Purpose: The number of seconds remaining before a lock expires.

Value: TimeType (defined in Section 10.7)

```
<!ELEMENT timeout (#PCDATA) >
```

14.30. write XML Element

Name: write

Purpose: Specifies a write lock.

```
<!ELEMENT write EMPTY >
```

15. DAV Properties

For DAV properties, the name of the property is also the same as the name of the XML element that contains its value. In the section below, the final line of each section gives the element type declaration using the format defined in [REC-XML]. The "Value" field, where present, specifies further restrictions on the allowable contents of the XML element using BNF (i.e., to further restrict the values of a PCDATA element).

A protected property is one that cannot be changed with a PROPPATCH request. There may be other requests that would result in a change to a protected property (as when a LOCK request affects the value of DAV:lockdiscovery). Note that a given property could be protected on one type of resource, but not protected on another type of resource.

A computed property is one with a value defined in terms of a computation (based on the content and other properties of that resource, or even of some other resource). A computed property is always a protected property.

COPY and MOVE behavior refers to local COPY and MOVE operations.

For properties defined based on HTTP GET response headers (DAV:get*), the header value could include LWS as defined in [RFC2616], Section 4.2. Server implementors SHOULD strip LWS from these values before using as WebDAV property values.

15.1. creationdate Property

Name: creationdate

Purpose: Records the time and date the resource was created.

Value: date-time (defined in [RFC3339], see the ABNF in Section 5.6.)

Protected: MAY be protected. Some servers allow DAV:creationdate to be changed to reflect the time the document was created if that is more meaningful to the user (rather than the time it was uploaded). Thus, clients SHOULD NOT use this property in synchronization logic (use DAV:getetag instead).

COPY/MOVE behavior: This property value SHOULD be kept during a MOVE operation, but is normally re-initialized when a resource is created with a COPY. It should not be set in a COPY.

Description: The DAV:creationdate property SHOULD be defined on all DAV compliant resources. If present, it contains a timestamp of the moment when the resource was created. Servers that are incapable of persistently recording the creation date SHOULD instead leave it undefined (i.e. report "Not Found").

<!ELEMENT creationdate (#PCDATA) >

15.2. displayname Property

Name: displayname

Purpose: Provides a name for the resource that is suitable for presentation to a user.

Value: Any text.

Protected: SHOULD NOT be protected. Note that servers implementing [RFC2518] might have made this a protected property as this is a new requirement.

COPY/MOVE behavior: This property value SHOULD be preserved in COPY and MOVE operations.

Description: Contains a description of the resource that is suitable for presentation to a user. This property is defined on the resource, and hence SHOULD have the same value independent of the Request-URI used to retrieve it (thus, computing this property based on the Request-URI is deprecated). While generic clients might display the property value to end users, client UI designers must understand that the method for identifying resources is still the URL. Changes to DAV:displayname do not issue moves or copies to the server, but simply change a piece of meta-data on the individual resource. Two resources can have the same DAV:displayname value even within the same collection.

<!ELEMENT displayname (#PCDATA) >

15.3. getcontentlanguage Property

Name: getcontentlanguage

Purpose: Contains the Content-Language header value (from Section 14.12 of [RFC2616]) as it would be returned by a GET without accept headers.

Value: language-tag (language-tag is defined in Section 3.10 of [RFC2616])

Protected: SHOULD NOT be protected, so that clients can reset the language. Note that servers implementing [RFC2518] might have made this a protected property as this is a new requirement.

COPY/MOVE behavior: This property value SHOULD be preserved in COPY and MOVE operations.

Description: The DAV:getcontentlanguage property MUST be defined on any DAV-compliant resource that returns the Content-Language header on a GET.

<!ELEMENT getcontentlanguage (#PCDATA) >

15.4. getcontentlength Property

Name: getcontentlength

Purpose: Contains the Content-Length header returned by a GET without accept headers.

Value: See Section 14.13 of [RFC2616].

Protected: This property is computed, therefore protected.

Description: The DAV:getcontentlength property MUST be defined on any DAV-compliant resource that returns the Content-Length header in response to a GET.

COPY/MOVE behavior: This property value is dependent on the size of the destination resource, not the value of the property on the source resource.

<!ELEMENT getcontentlength (#PCDATA) >

15.5. getcontenttype Property

Name: getcontenttype

Purpose: Contains the Content-Type header value (from Section 14.17 of [RFC2616]) as it would be returned by a GET without accept headers.

Value: media-type (defined in Section 3.7 of [RFC2616])

Protected: Potentially protected if the server prefers to assign content types on its own (see also discussion in Section 9.7.1).

COPY/MOVE behavior: This property value SHOULD be preserved in COPY and MOVE operations.

Description: This property MUST be defined on any DAV-compliant resource that returns the Content-Type header in response to a GET.

<!ELEMENT getcontenttype (#PCDATA) >

15.6. getetag Property

Name: getetag

Purpose: Contains the ETag header value (from Section 14.19 of [RFC2616]) as it would be returned by a GET without accept headers.

Value: entity-tag (defined in Section 3.11 of [RFC2616])

Protected: MUST be protected because this value is created and controlled by the server.

COPY/MOVE behavior: This property value is dependent on the final state of the destination resource, not the value of the property on the source resource. Also note the considerations in Section 8.8.

Description: The getetag property MUST be defined on any DAV-compliant resource that returns the Etag header. Refer to Section 3.11 of RFC 2616 for a complete definition of the semantics of an ETag, and to Section 8.6 for a discussion of ETags in WebDAV.

<!ELEMENT getetag (#PCDATA) >

15.7. getlastmodified Property

Name: getlastmodified

Purpose: Contains the Last-Modified header value (from Section 14.29 of [RFC2616]) as it would be returned by a GET method without accept headers.

Value: rfc1123-date (defined in Section 3.3.1 of [RFC2616])

Protected: SHOULD be protected because some clients may rely on the value for appropriate caching behavior, or on the value of the Last-Modified header to which this property is linked.

COPY/MOVE behavior: This property value is dependent on the last modified date of the destination resource, not the value of the property on the source resource. Note that some server implementations use the file system date modified value for the DAV:getlastmodified value, and this can be preserved in a MOVE even when the HTTP Last-Modified value SHOULD change. Note that since [RFC2616] requires clients to use ETags where provided, a server implementing ETags can count on clients using a much better mechanism than modification dates for offline synchronization or cache control. Also note the considerations in Section 8.8.

Description: The last-modified date on a resource SHOULD only reflect changes in the body (the GET responses) of the resource. A change in a property only SHOULD NOT cause the last-modified date to change, because clients MAY rely on the last-modified date to know when to overwrite the existing body. The DAV:getlastmodified property MUST be defined on any DAV-compliant resource that returns the Last-Modified header in response to a GET.

```
<!ELEMENT getlastmodified (#PCDATA) >
```

15.8. lockdiscovery Property

Name: lockdiscovery

Purpose: Describes the active locks on a resource

Protected: MUST be protected. Clients change the list of locks through LOCK and UNLOCK, not through PROPPATCH.

COPY/MOVE behavior: The value of this property depends on the lock state of the destination, not on the locks of the source resource. Recall that locks are not moved in a MOVE operation.

Description: Returns a listing of who has a lock, what type of lock he has, the timeout type and the time remaining on the timeout, and the associated lock token. Owner information MAY be omitted if it is considered sensitive. If there are no locks, but the server supports locks, the property will be present but contain zero 'activelock' elements. If there are one or more locks, an 'activelock' element appears for each lock on the resource. This property is NOT lockable with respect to write locks (Section 7).

```
<!ELEMENT lockdiscovery (activelock)* >
```

15.8.1. Example - Retrieving DAV:lockdiscovery

>>Request

```
PROPFIND /container/ HTTP/1.1
Host: www.example.com
Content-Length: xxxx
Content-Type: application/xml; charset="utf-8"
```

```
<?xml version="1.0" encoding="utf-8" ?>
<D:propfind xmlns:D='DAV:'>
  <D:prop><D:lockdiscovery/></D:prop>
</D:propfind>
```

>>Response

```
HTTP/1.1 207 Multi-Status
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx
```

```
<?xml version="1.0" encoding="utf-8" ?>
<D:multistatus xmlns:D='DAV:'>
  <D:response>
    <D:href>http://www.example.com/container/</D:href>
    <D:propstat>
      <D:prop>
        <D:lockdiscovery>
          <D:activelock>
            <D:locktype><D:write/></D:locktype>
            <D:lockscope><D:exclusive/></D:lockscope>
            <D:depth>0</D:depth>
            <D:owner>Jane Smith</D:owner>
            <D:timeout>Infinite</D:timeout>
            <D:locktoken>
              <D:href>
                >urn:uuid:f81de2ad-7f3d-a1b2-4f3c-00a0c91a9d76</D:href>
              </D:locktoken>
            <D:lockroot>
              <D:href>http://www.example.com/container/</D:href>
            </D:lockroot>
          </D:activelock>
        </D:lockdiscovery>
      </D:prop>
      <D:status>HTTP/1.1 200 OK</D:status>
    </D:propstat>
  </D:response>
</D:multistatus>
```

This resource has a single exclusive write lock on it, with an infinite timeout.

15.9. resourcetype Property

Name: resourcetype

Purpose: Specifies the nature of the resource.

Protected: SHOULD be protected. Resource type is generally decided through the operation creating the resource (MKCOL vs PUT), not by PROPPATCH.

COPY/MOVE behavior: Generally a COPY/MOVE of a resource results in the same type of resource at the destination.

Description: MUST be defined on all DAV-compliant resources. Each child element identifies a specific type the resource belongs to, such as 'collection', which is the only resource type defined by this specification (see Section 14.3). If the element contains the 'collection' child element plus additional unrecognized elements, it should generally be treated as a collection. If the element contains no recognized child elements, it should be treated as a non-collection resource. The default value is empty. This element MUST NOT contain text or mixed content. Any custom child element is considered to be an identifier for a resource type.

Example: (fictional example to show extensibility)

```
<x:resourcetype xmlns:x="DAV:">
  <x:collection/>
  <f:search-results xmlns:f="http://www.example.com/ns"/>
</x:resourcetype>
```

15.10. supportedlock Property

Name: supportedlock

Purpose: To provide a listing of the lock capabilities supported by the resource.

Protected: MUST be protected. Servers, not clients, determine what lock mechanisms are supported.

COPY/MOVE behavior: This property value is dependent on the kind of locks supported at the destination, not on the value of the property at the source resource. Servers attempting to COPY to a destination should not attempt to set this property at the destination.

Description: Returns a listing of the combinations of scope and access types that may be specified in a lock request on the resource. Note that the actual contents are themselves controlled by access controls, so a server is not required to provide information the client is not authorized to see. This property is NOT lockable with respect to write locks (Section 7).

<!ELEMENT supportedlock (lockentry)* >

15.10.1. Example - Retrieving DAV:supportedlock

>>Request

```
PROPFIND /container/ HTTP/1.1
Host: www.example.com
Content-Length: xxxx
Content-Type: application/xml; charset="utf-8"
```

```
<?xml version="1.0" encoding="utf-8" ?>
<D:propfind xmlns:D="DAV:">
  <D:prop><D:supportedlock/></D:prop>
</D:propfind>
```

>>Response

```
HTTP/1.1 207 Multi-Status
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx
```

```
<?xml version="1.0" encoding="utf-8" ?>
<D:multistatus xmlns:D="DAV:">
  <D:response>
    <D:href>http://www.example.com/container/</D:href>
    <D:propstat>
      <D:prop>
        <D:supportedlock>
          <D:lockentry>
            <D:lockscope><D:exclusive/></D:lockscope>
            <D:locktype><D:write/></D:locktype>
          </D:lockentry>
          <D:lockentry>
            <D:lockscope><D:shared/></D:lockscope>
```

```

    <D:locktype><D:write/></D:locktype>
  </D:lockentry>
</D:supportedlock>
</D:prop>
<D:status>HTTP/1.1 200 OK</D:status>
</D:propstat>
</D:response>
</D:multistatus>

```

16. Precondition/Postcondition XML Elements

As introduced in Section 8.7, extra information on error conditions can be included in the body of many status responses. This section makes requirements on the use of the error body mechanism and introduces a number of precondition and postcondition codes.

A "precondition" of a method describes the state of the server that must be true for that method to be performed. A "postcondition" of a method describes the state of the server that must be true after that method has been completed.

Each precondition and postcondition has a unique XML element associated with it. In a 207 Multi-Status response, the XML element MUST appear inside an 'error' element in the appropriate 'propstat' or 'response' element depending on whether the condition applies to one or more properties or to the resource as a whole. In all other error responses where this specification's 'error' body is used, the precondition/postcondition XML element MUST be returned as the child of a top-level 'error' element in the response body, unless otherwise negotiated by the request, along with an appropriate response status. The most common response status codes are 403 (Forbidden) if the request should not be repeated because it will always fail, and 409 (Conflict) if it is expected that the user might be able to resolve the conflict and resubmit the request. The 'error' element MAY contain child elements with specific error information and MAY be extended with any custom child elements.

This mechanism does not take the place of using a correct numeric status code as defined here or in HTTP, because the client must always be able to take a reasonable course of action based only on the numeric code. However, it does remove the need to define new numeric codes. The new machine-readable codes used for this purpose are XML elements classified as preconditions and postconditions, so naturally, any group defining a new condition code can use their own namespace. As always, the "DAV:" namespace is reserved for use by IETF-chartered WebDAV working groups.

A server supporting this specification SHOULD use the XML error whenever a precondition or postcondition defined in this document is violated. For error conditions not specified in this document, the server MAY simply choose an appropriate numeric status and leave the response body blank. However, a server MAY instead use a custom condition code and other supporting text, because even when clients do not automatically recognize condition codes, they can be quite useful in interoperability testing and debugging.

Example - Response with precondition code

>>Response

```
HTTP/1.1 423 Locked
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx

<?xml version="1.0" encoding="utf-8" ?>
<D:error xmlns:D="DAV:">
  <D:lock-token-submitted>
    <D:href>/workspace/webdav/</D:href>
  </D:lock-token-submitted>
</D:error>
```

In this example, a client unaware of a depth-infinity lock on the parent collection `"/workspace/webdav/"` attempted to modify the collection member `"/workspace/webdav/proposal.doc"`.

Some other useful preconditions and postconditions have been defined in other specifications extending WebDAV, such as [RFC3744] (see particularly Section 7.1.1), [RFC3253], and [RFC3648].

All these elements are in the "DAV:" namespace. If not specified otherwise, the content for each condition's XML element is defined to be empty.

Name: lock-token-matches-request-uri

Use with: 409 Conflict

Purpose: (precondition) -- A request may include a Lock-Token header to identify a lock for the UNLOCK method. However, if the Request-URI does not fall within the scope of the lock identified by the token, the server SHOULD use this error. The lock may have a scope that does not include the Request-URI, or the lock could have disappeared, or the token may be invalid.

Name: lock-token-submitted (precondition)

Use with: 423 Locked

Purpose: The request could not succeed because a lock token should have been submitted. This element, if present, MUST contain at least one URL of a locked resource that prevented the request. In cases of MOVE, COPY, and DELETE where collection locks are involved, it can be difficult for the client to find out which locked resource made the request fail -- but the server is only responsible for returning one such locked resource. The server MAY return every locked resource that prevented the request from succeeding if it knows them all.

<!ELEMENT lock-token-submitted (href+) >

Name: no-conflicting-lock (precondition)

Use with: Typically 423 Locked

Purpose: A LOCK request failed due the presence of an already existing conflicting lock. Note that a lock can be in conflict although the resource to which the request was directed is only indirectly locked. In this case, the precondition code can be used to inform the client about the resource that is the root of the conflicting lock, avoiding a separate lookup of the "lockdiscovery" property.

<!ELEMENT no-conflicting-lock (href)* >

Name: no-external-entities

Use with: 403 Forbidden

Purpose: (precondition) -- If the server rejects a client request because the request body contains an external entity, the server SHOULD use this error.

Name: preserved-live-properties

Use with: 409 Conflict

Purpose: (postcondition) -- The server received an otherwise-valid MOVE or COPY request, but cannot maintain the live properties with the same behavior at the destination. It may be that the server

only supports some live properties in some parts of the repository, or simply has an internal error.

Name: propfind-finite-depth

Use with: 403 Forbidden

Purpose: (precondition) -- This server does not allow infinite-depth PROPFIND requests on collections.

Name: cannot-modify-protected-property

Use with: 403 Forbidden

Purpose: (precondition) -- The client attempted to set a protected property in a PROPPATCH (such as DAV:getetag). See also [RFC3253], Section 3.12.

17. XML Extensibility in DAV

The XML namespace extension ([REC-XML-NAMES]) is used in this specification in order to allow for new XML elements to be added without fear of colliding with other element names. Although WebDAV request and response bodies can be extended by arbitrary XML elements, which can be ignored by the message recipient, an XML element in the "DAV:" namespace SHOULD NOT be used in the request or response body unless that XML element is explicitly defined in an IETF RFC reviewed by a WebDAV working group.

For WebDAV to be both extensible and backwards-compatible, both clients and servers need to know how to behave when unexpected or unrecognized command extensions are received. For XML processing, this means that clients and servers MUST process received XML documents as if unexpected elements and attributes (and all children of unrecognized elements) were not there. An unexpected element or attribute includes one that may be used in another context but is not expected here. Ignoring such items for purposes of processing can of course be consistent with logging all information or presenting for debugging.

This restriction also applies to the processing, by clients, of DAV property values where unexpected XML elements SHOULD be ignored unless the property's schema declares otherwise.

This restriction does not apply to setting dead DAV properties on the server where the server MUST record all XML elements.

Additionally, this restriction does not apply to the use of XML where XML happens to be the content type of the entity body, for example, when used as the body of a PUT.

Processing instructions in XML SHOULD be ignored by recipients. Thus, specifications extending WebDAV SHOULD NOT use processing instructions to define normative behavior.

XML DTD fragments are included for all the XML elements defined in this specification. However, correct XML will not be valid according to any DTD due to namespace usage and extension rules. In particular:

- o Elements (from this specification) are in the "DAV:" namespace,
- o Element ordering is irrelevant unless otherwise stated,
- o Extension attributes MAY be added,
- o For element type definitions of "ANY", the normative text definition for that element defines what can be in it and what that means.
- o For element type definitions of "#PCDATA", extension elements MUST NOT be added.
- o For other element type definitions, including "EMPTY", extension elements MAY be added.

Note that this means that elements containing elements cannot be extended to contain text, and vice versa.

With DTD validation relaxed by the rules above, the constraints described by the DTD fragments are normative (see for example Appendix A). A recipient of a WebDAV message with an XML body MUST NOT validate the XML document according to any hard-coded or dynamically-declared DTD.

Note that this section describes backwards-compatible extensibility rules. There might also be times when an extension is designed not to be backwards-compatible, for example, defining an extension that reuses an XML element defined in this document but omitting one of the child elements required by the DTDs in this specification.

18. DAV Compliance Classes

A DAV-compliant resource can advertise several classes of compliance. A client can discover the compliance classes of a resource by executing OPTIONS on the resource and examining the "DAV" header which is returned. Note particularly that resources, rather than servers, are spoken of as being compliant. That is because theoretically some resources on a server could support different feature sets. For example, a server could have a sub-repository where an advanced feature like versioning was supported, even if that feature was not supported on all sub-repositories.

Since this document describes extensions to the HTTP/1.1 protocol, minimally all DAV-compliant resources, clients, and proxies MUST be compliant with [RFC2616].

A resource that is class 2 or class 3 compliant must also be class 1 compliant.

18.1. Class 1

A class 1 compliant resource MUST meet all "MUST" requirements in all sections of this document.

Class 1 compliant resources MUST return, at minimum, the value "1" in the DAV header on all responses to the OPTIONS method.

18.2. Class 2

A class 2 compliant resource MUST meet all class 1 requirements and support the LOCK method, the DAV:supportedlock property, the DAV:lockdiscovery property, the Time-Out response header and the Lock-Token request header. A class 2 compliant resource SHOULD also support the Timeout request header and the 'owner' XML element.

Class 2 compliant resources MUST return, at minimum, the values "1" and "2" in the DAV header on all responses to the OPTIONS method.

18.3. Class 3

A resource can explicitly advertise its support for the revisions to [RFC2518] made in this document. Class 1 MUST be supported as well. Class 2 MAY be supported. Advertising class 3 support in addition to class 1 and 2 means that the server supports all the requirements in this specification. Advertising class 3 and class 1 support, but not class 2, means that the server supports all the requirements in this specification except possibly those that involve locking support.

Example:

DAV: 1, 3

19. Internationalization Considerations

In the realm of internationalization, this specification complies with the IETF Character Set Policy [RFC2277]. In this specification, human-readable fields can be found either in the value of a property, or in an error message returned in a response entity body. In both cases, the human-readable content is encoded using XML, which has explicit provisions for character set tagging and encoding, and requires that XML processors read XML elements encoded, at minimum, using the UTF-8 [RFC3629] and UTF-16 [RFC2781] encodings of the ISO 10646 multilingual plane. XML examples in this specification demonstrate use of the charset parameter of the Content-Type header (defined in [RFC3023]), as well as XML charset declarations.

XML also provides a language tagging capability for specifying the language of the contents of a particular XML element. The "xml:lang" attribute appears on an XML element to identify the language of its content and attributes. See [REC-XML] for definitions of values and scoping.

WebDAV applications MUST support the character set tagging, character set encoding, and the language tagging functionality of the XML specification. Implementors of WebDAV applications are strongly encouraged to read "XML Media Types" [RFC3023] for instruction on which MIME media type to use for XML transport, and on use of the charset parameter of the Content-Type header.

Names used within this specification fall into four categories: names of protocol elements such as methods and headers, names of XML elements, names of properties, and names of conditions. Naming of protocol elements follows the precedent of HTTP, using English names encoded in US-ASCII for methods and headers. Since these protocol elements are not visible to users, and are simply long token identifiers, they do not need to support multiple languages. Similarly, the names of XML elements used in this specification are not visible to the user and hence do not need to support multiple languages.

WebDAV property names are qualified XML names (pairs of XML namespace name and local name). Although some applications (e.g., a generic property viewer) will display property names directly to their users, it is expected that the typical application will use a fixed set of properties, and will provide a mapping from the property name and namespace to a human-readable field when displaying the property name

to a user. It is only in the case where the set of properties is not known ahead of time that an application need display a property name to a user. We recommend that applications provide human-readable property names wherever feasible.

For error reporting, we follow the convention of HTTP/1.1 status codes, including with each status code a short, English description of the code (e.g., 423 (Locked)). While the possibility exists that a poorly crafted user agent would display this message to a user, internationalized applications will ignore this message, and display an appropriate message in the user's language and character set.

Since interoperation of clients and servers does not require locale information, this specification does not specify any mechanism for transmission of this information.

20. Security Considerations

This section is provided to detail issues concerning security implications of which WebDAV applications need to be aware.

All of the security considerations of HTTP/1.1 (discussed in [RFC2616]) and XML (discussed in [RFC3023]) also apply to WebDAV. In addition, the security risks inherent in remote authoring require stronger authentication technology, introduce several new privacy concerns, and may increase the hazards from poor server design. These issues are detailed below.

20.1. Authentication of Clients

Due to their emphasis on authoring, WebDAV servers need to use authentication technology to protect not just access to a network resource, but the integrity of the resource as well. Furthermore, the introduction of locking functionality requires support for authentication.

A password sent in the clear over an insecure channel is an inadequate means for protecting the accessibility and integrity of a resource as the password may be intercepted. Since Basic authentication for HTTP/1.1 performs essentially clear text transmission of a password, Basic authentication MUST NOT be used to authenticate a WebDAV client to a server unless the connection is secure. Furthermore, a WebDAV server MUST NOT send a Basic authentication challenge in a WWW-Authenticate header unless the connection is secure. An example of a secure connection would be a Transport Layer Security (TLS) connection employing a strong cipher suite and server authentication.

WebDAV applications MUST support the Digest authentication scheme [RFC2617]. Since Digest authentication verifies that both parties to a communication know a shared secret, a password, without having to send that secret in the clear, Digest authentication avoids the security problems inherent in Basic authentication while providing a level of authentication that is useful in a wide range of scenarios.

20.2. Denial of Service

Denial-of-service attacks are of special concern to WebDAV servers. WebDAV plus HTTP enables denial-of-service attacks on every part of a system's resources.

- o The underlying storage can be attacked by PUTting extremely large files.
- o Asking for recursive operations on large collections can attack processing time.
- o Making multiple pipelined requests on multiple connections can attack network connections.

WebDAV servers need to be aware of the possibility of a denial-of-service attack at all levels. The proper response to such an attack MAY be to simply drop the connection. Or, if the server is able to make a response, the server MAY use a 400-level status request such as 400 (Bad Request) and indicate why the request was refused (a 500-level status response would indicate that the problem is with the server, whereas unintentional DoS attacks are something the client is capable of remedying).

20.3. Security through Obscurity

WebDAV provides, through the PROPFIND method, a mechanism for listing the member resources of a collection. This greatly diminishes the effectiveness of security or privacy techniques that rely only on the difficulty of discovering the names of network resources. Users of WebDAV servers are encouraged to use access control techniques to prevent unwanted access to resources, rather than depending on the relative obscurity of their resource names.

20.4. Privacy Issues Connected to Locks

When submitting a lock request, a user agent may also submit an 'owner' XML field giving contact information for the person taking out the lock (for those cases where a person, rather than a robot, is taking out the lock). This contact information is stored in a DAV:lockdiscovery property on the resource, and can be used by other

collaborators to begin negotiation over access to the resource. However, in many cases, this contact information can be very private, and should not be widely disseminated. Servers SHOULD limit read access to the DAV:lockdiscovery property as appropriate. Furthermore, user agents SHOULD provide control over whether contact information is sent at all, and if contact information is sent, control over exactly what information is sent.

20.5. Privacy Issues Connected to Properties

Since property values are typically used to hold information such as the author of a document, there is the possibility that privacy concerns could arise stemming from widespread access to a resource's property data. To reduce the risk of inadvertent release of private information via properties, servers are encouraged to develop access control mechanisms that separate read access to the resource body and read access to the resource's properties. This allows a user to control the dissemination of their property data without overly restricting access to the resource's contents.

20.6. Implications of XML Entities

XML supports a facility known as "external entities", defined in Section 4.2.2 of [REC-XML], which instructs an XML processor to retrieve and include additional XML. An external XML entity can be used to append or modify the document type declaration (DTD) associated with an XML document. An external XML entity can also be used to include XML within the content of an XML document. For non-validating XML, such as the XML used in this specification, including an external XML entity is not required by XML. However, XML does state that an XML processor may, at its discretion, include the external XML entity.

External XML entities have no inherent trustworthiness and are subject to all the attacks that are endemic to any HTTP GET request. Furthermore, it is possible for an external XML entity to modify the DTD, and hence affect the final form of an XML document, in the worst case, significantly modifying its semantics or exposing the XML processor to the security risks discussed in [RFC3023]. Therefore, implementers must be aware that external XML entities should be treated as untrustworthy. If a server chooses not to handle external XML entities, it SHOULD respond to requests containing external entities with the 'no-external-entities' condition code.

There is also the scalability risk that would accompany a widely deployed application that made use of external XML entities. In this situation, it is possible that there would be significant numbers of requests for one external XML entity, potentially overloading any

server that fields requests for the resource containing the external XML entity.

Furthermore, there's also a risk based on the evaluation of "internal entities" as defined in Section 4.2.2 of [REC-XML]. A small, carefully crafted request using nested internal entities may require enormous amounts of memory and/or processing time to process. Server implementers should be aware of this risk and configure their XML parsers so that requests like these can be detected and rejected as early as possible.

20.7. Risks Connected with Lock Tokens

This specification encourages the use of "A Universally Unique Identifier (UUID) URN Namespace" ([RFC4122]) for lock tokens (Section 6.5), in order to guarantee their uniqueness across space and time. Version 1 UUIDs (defined in Section 4) MAY contain a "node" field that "consists of an IEEE 802 MAC address, usually the host address. For systems with multiple IEEE addresses, any available one can be used". Since a WebDAV server will issue many locks over its lifetime, the implication is that it may also be publicly exposing its IEEE 802 address.

There are several risks associated with exposure of IEEE 802 addresses. Using the IEEE 802 address:

- o It is possible to track the movement of hardware from subnet to subnet.
- o It may be possible to identify the manufacturer of the hardware running a WebDAV server.
- o It may be possible to determine the number of each type of computer running WebDAV.

This risk only applies to host-address-based UUID versions. Section 4 of [RFC4122] describes several other mechanisms for generating UUIDs that do not involve the host address and therefore do not suffer from this risk.

20.8. Hosting Malicious Content

HTTP has the ability to host programs that are executed on client machines. These programs can take many forms including Web scripts, executables, plug-in modules, and macros in documents. WebDAV does not change any of the security concerns around these programs, yet often WebDAV is used in contexts where a wide range of users can publish documents on a server. The server might not have a close

trust relationship with the author that is publishing the document. Servers that allow clients to publish arbitrary content can usefully implement precautions to check that content published to the server is not harmful to other clients. Servers could do this by techniques such as restricting the types of content that is allowed to be published and running virus and malware detection software on published content. Servers can also mitigate the risk by having appropriate access restriction and authentication of users that are allowed to publish content to the server.

21. IANA Considerations

21.1. New URI Schemes

This specification defines two URI schemes:

1. the "opaquelocktoken" scheme defined in Appendix C, and
2. the "DAV" URI scheme, which historically was used in [RFC2518] to disambiguate WebDAV property and XML element names and which continues to be used for that purpose in this specification and others extending WebDAV. Creation of identifiers in the "DAV:" namespace is controlled by the IETF.

Note that defining new URI schemes for XML namespaces is now discouraged. "DAV:" was defined before standard best practices emerged.

21.2. XML Namespaces

XML namespaces disambiguate WebDAV property names and XML elements. Any WebDAV user or application can define a new namespace in order to create custom properties or extend WebDAV XML syntax. IANA does not need to manage such namespaces, property names, or element names.

21.3. Message Header Fields

The message header fields below should be added to the permanent registry (see [RFC3864]).

21.3.1. DAV

Header field name: DAV

Applicable protocol: http

Status: standard

Author/Change controller: IETF

Specification document: this specification (Section 10.1)

21.3.2. Depth

Header field name: Depth

Applicable protocol: http

Status: standard

Author/Change controller: IETF

Specification document: this specification (Section 10.2)

21.3.3. Destination

Header field name: Destination

Applicable protocol: http

Status: standard

Author/Change controller: IETF

Specification document: this specification (Section 10.3)

21.3.4. If

Header field name: If

Applicable protocol: http

Status: standard

Author/Change controller: IETF

Specification document: this specification (Section 10.4)

21.3.5. Lock-Token

Header field name: Lock-Token

Applicable protocol: http

Status: standard

Author/Change controller: IETF

Specification document: this specification (Section 10.5)

21.3.6. Overwrite

Header field name: Overwrite

Applicable protocol: http

Status: standard

Author/Change controller: IETF

Specification document: this specification (Section 10.6)

21.3.7. Timeout

Header field name: Timeout

Applicable protocol: http

Status: standard

Author/Change controller: IETF

Specification document: this specification (Section 10.7)

21.4. HTTP Status Codes

This specification defines the HTTP status codes

- o 207 Multi-Status (Section 11.1)
- o 422 Unprocessable Entity (Section 11.2),
- o 423 Locked (Section 11.3),
- o 424 Failed Dependency (Section 11.4) and
- o 507 Insufficient Storage (Section 11.5),

to be updated in the registry at
<<http://www.iana.org/assignments/http-status-codes>>.

Note: the HTTP status code 102 (Processing) has been removed in this specification; its IANA registration should continue to reference RFC 2518.

22. Acknowledgements

A specification such as this thrives on piercing critical review and withers from apathetic neglect. The authors gratefully acknowledge the contributions of the following people, whose insights were so valuable at every stage of our work.

Contributors to RFC 2518

Terry Allen, Harald Alvestrand, Jim Amsden, Becky Anderson, Alan Babich, Sanford Barr, Dylan Barrell, Bernard Chester, Tim Berners-Lee, Dan Connolly, Jim Cunningham, Ron Daniel, Jr., Jim Davis, Keith Dawson, Mark Day, Brian Deen, Martin Duerst, David Durand, Lee Farrell, Chuck Fay, Wesley Felter, Roy Fielding, Mark Fisher, Alan Freier, George Florentine, Jim Gettys, Phill Hallam-Baker, Dennis Hamilton, Steve Henning, Mead Himelstein, Alex Hopmann, Andre van der Hoek, Ben Laurie, Paul Leach, Ora Lassila, Karen MacArthur, Steven Martin, Larry Masinter, Michael Mealling, Keith Moore, Thomas Narten, Henrik Nielsen, Kenji Ota, Bob Parker, Glenn Peterson, Jon Radoff, Saveen Reddy, Henry Sanders, Christopher Seiwald, Judith Slein, Mike Spreitzer, Einar Stefferud, Greg Stein, Ralph Swick, Kenji Takahashi, Richard N. Taylor, Robert Thau, John Turner, Sankar Virdhagriswaran, Fabio Vitali, Gregory Woodhouse, and Lauren Wood.

Two from this list deserve special mention. The contributions by Larry Masinter have been invaluable; he both helped the formation of the working group and patiently coached the authors along the way. In so many ways he has set high standards that we have toiled to meet. The contributions of Judith Slein were also invaluable; by clarifying the requirements and in patiently reviewing version after version, she both improved this specification and expanded our minds on document management.

We would also like to thank John Turner for developing the XML DTD.

The authors of RFC 2518 were Yaron Goland, Jim Whitehead, A. Faizi, Steve Carter, and D. Jensen. Although their names had to be removed due to IETF author count restrictions, they can take credit for the majority of the design of WebDAV.

Additional Acknowledgements for This Specification

Significant contributors of text for this specification are listed as contributors in the section below. We must also gratefully acknowledge Geoff Clemm, Joel Soderberg, and Dan Brotsky for hashing out specific text on the list or in meetings. Joe Hildebrand and Cullen Jennings helped close many issues. Barry Lind described an additional security consideration and Cullen Jennings provided text

for that consideration. Jason Crawford tracked issue status for this document for a period of years, followed by Elias Sinderson.

23. Contributors to This Specification

Julian Reschke
<green/>bytes GmbH
Hafenweg 16, 48155 Muenster, Germany
EMail: julian.reschke@greenbytes.de

Elias Sinderson
University of California, Santa Cruz
1156 High Street, Santa Cruz, CA 95064
EMail: elias@cse.ucsc.edu

Jim Whitehead
University of California, Santa Cruz
1156 High Street, Santa Cruz, CA 95064
EMail: ejw@soe.ucsc.edu

24. Authors of RFC 2518

Y. Y. Goland
Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
EMail: yarong@microsoft.com

E. J. Whitehead, Jr.
Dept. Of Information and Computer Science
University of California, Irvine
Irvine, CA 92697-3425
EMail: ejw@ics.uci.edu

A. Faizi
Netscape
685 East Middlefield Road
Mountain View, CA 94043
EMail: asad@netscape.com

S. R. Carter
Novell
1555 N. Technology Way
M/S ORM F111
Orem, UT 84097-2399
EMail: srcarter@novell.com

D. Jensen
Novell
1555 N. Technology Way
M/S ORM F111
Orem, UT 84097-2399
EMail: dcjensen@novell.com

25. References

25.1. Normative References

- [REC-XML] Bray, T., Paoli, J., Sperberg-McQueen, C., Maler, E., and F. Yergeau, "Extensible Markup Language (XML) 1.0 (Fourth Edition)", W3C REC-xml-20060816, August 2006, <<http://www.w3.org/TR/2006/REC-xml-20060816/>>.
- [REC-XML-INFOSET] Cowan, J. and R. Tobin, "XML Information Set (Second Edition)", W3C REC-xml-infoset-20040204, February 2004, <<http://www.w3.org/TR/2004/REC-xml-infoset-20040204/>>.
- [REC-XML-NAMES] Bray, T., Hollander, D., Layman, A., and R. Tobin, "Namespaces in XML 1.0 (Second Edition)", W3C REC-xml-names-20060816, August 2006, <<http://www.w3.org/TR/2006/REC-xml-names-20060816/>>.
- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.
- [RFC2277] Alvestrand, H., "IETF Policy on Character Sets and Languages", BCP 18, RFC 2277, January 1998.
- [RFC2616] Fielding, R., Gettys, J., Mogul, J., Frystyk, H., Masinter, L., Leach, P., and T. Berners-Lee, "Hypertext Transfer Protocol -- HTTP/1.1", RFC 2616, June 1999.

- [RFC2617] Franks, J., Hallam-Baker, P., Hostetler, J., Lawrence, S., Leach, P., Luotonen, A., and L. Stewart, "HTTP Authentication: Basic and Digest Access Authentication", RFC 2617, June 1999.
- [RFC3339] Klyne, G., Ed. and C. Newman, "Date and Time on the Internet: Timestamps", RFC 3339, July 2002.
- [RFC3629] Yergeau, F., "UTF-8, a transformation format of ISO 10646", STD 63, RFC 3629, November 2003.
- [RFC3986] Berners-Lee, T., Fielding, R., and L. Masinter, "Uniform Resource Identifier (URI): Generic Syntax", STD 66, RFC 3986, January 2005.
- [RFC4122] Leach, P., Mealling, M., and R. Salz, "A Universally Unique IDentifier (UUID) URN Namespace", RFC 4122, July 2005.

25.2. Informative References

- [RFC2291] Slein, J., Vitali, F., Whitehead, E., and D. Durand, "Requirements for a Distributed Authoring and Versioning Protocol for the World Wide Web", RFC 2291, February 1998.
- [RFC2518] Goland, Y., Whitehead, E., Faizi, A., Carter, S., and D. Jensen, "HTTP Extensions for Distributed Authoring -- WEBDAV", RFC 2518, February 1999.
- [RFC2781] Hoffman, P. and F. Yergeau, "UTF-16, an encoding of ISO 10646", RFC 2781, February 2000.
- [RFC3023] Murata, M., St. Laurent, S., and D. Kohn, "XML Media Types", RFC 3023, January 2001.
- [RFC3253] Clemm, G., Amsden, J., Ellison, T., Kaler, C., and J. Whitehead, "Versioning Extensions to WebDAV (Web Distributed Authoring and Versioning)", RFC 3253, March 2002.
- [RFC3648] Whitehead, J. and J. Reschke, Ed., "Web Distributed Authoring and Versioning (WebDAV) Ordered Collections Protocol", RFC 3648, December 2003.

- [RFC3744] Clemm, G., Reschke, J., Sedlar, E., and J. Whitehead, "Web Distributed Authoring and Versioning (WebDAV) Access Control Protocol", RFC 3744, May 2004.
- [RFC3864] Klyne, G., Nottingham, M., and J. Mogul, "Registration Procedures for Message Header Fields", BCP 90, RFC 3864, September 2004.

Appendix A. Notes on Processing XML Elements

A.1. Notes on Empty XML Elements

XML supports two mechanisms for indicating that an XML element does not have any content. The first is to declare an XML element of the form `<A>`. The second is to declare an XML element of the form `<A/>`. The two XML elements are semantically identical.

A.2. Notes on Illegal XML Processing

XML is a flexible data format that makes it easy to submit data that appears legal but in fact is not. The philosophy of "Be flexible in what you accept and strict in what you send" still applies, but it must not be applied inappropriately. XML is extremely flexible in dealing with issues of whitespace, element ordering, inserting new elements, etc. This flexibility does not require extension, especially not in the area of the meaning of elements.

There is no kindness in accepting illegal combinations of XML elements. At best, it will cause an unwanted result and at worst it can cause real damage.

A.3. Example - XML Syntax Error

The following request body for a PROPFIND method is illegal.

```
<?xml version="1.0" encoding="utf-8" ?>
<D:propfind xmlns:D="DAV:">
  <D:allprop/>
  <D:propname/>
</D:propfind>
```

The definition of the propfind element only allows for the allprop or the propname element, not both. Thus, the above is an error and must be responded to with a 400 (Bad Request).

Imagine, however, that a server wanted to be "kind" and decided to pick the allprop element as the true element and respond to it. A client running over a bandwidth limited line who intended to execute a propname would be in for a big surprise if the server treated the command as an allprop.

Additionally, if a server were lenient and decided to reply to this request, the results would vary randomly from server to server, with some servers executing the allprop directive, and others executing the propname directive. This reduces interoperability rather than increasing it.

A.4. Example - Unexpected XML Element

The previous example was illegal because it contained two elements that were explicitly banned from appearing together in the propfind element. However, XML is an extensible language, so one can imagine new elements being defined for use with propfind. Below is the request body of a PROPFIND and, like the previous example, must be rejected with a 400 (Bad Request) by a server that does not understand the expired-props element.

```
<?xml version="1.0" encoding="utf-8" ?>
<D:propfind xmlns:D="DAV:"
  xmlns:E="http://www.example.com/standards/props/">
  <E:expired-props/>
</D:propfind>
```

To understand why a 400 (Bad Request) is returned, let us look at the request body as the server unfamiliar with expired-props sees it.

```
<?xml version="1.0" encoding="utf-8" ?>
<D:propfind xmlns:D="DAV:"
  xmlns:E="http://www.example.com/standards/props/">
</D:propfind>
```

As the server does not understand the 'expired-props' element, according to the WebDAV-specific XML processing rules specified in Section 17, it must process the request as if the element were not there. Thus, the server sees an empty propfind, which by the definition of the propfind element is illegal.

Please note that had the extension been additive, it would not necessarily have resulted in a 400 (Bad Request). For example, imagine the following request body for a PROPFIND:

```
<?xml version="1.0" encoding="utf-8" ?>
<D:propfind xmlns:D="DAV:"
  xmlns:E="http://www.example.com/standards/props/">
  <D:propname/>
  <E:leave-out>*boss*</E:leave-out>
</D:propfind>
```

The previous example contains the fictitious element leave-out. Its purpose is to prevent the return of any property whose name matches the submitted pattern. If the previous example were submitted to a server unfamiliar with 'leave-out', the only result would be that the 'leave-out' element would be ignored and a propname would be executed.

Appendix B. Notes on HTTP Client Compatibility

WebDAV was designed to be, and has been found to be, backward-compatible with HTTP 1.1. The PUT and DELETE methods are defined in HTTP and thus may be used by HTTP clients as well as WebDAV-aware clients, but the responses to PUT and DELETE have been extended in this specification in ways that only a WebDAV client would be entirely prepared for. Some theoretical concerns were raised about whether those responses would cause interoperability problems with HTTP-only clients, and this section addresses those concerns.

Since any HTTP client ought to handle unrecognized 400-level and 500-level status codes as errors, the following new status codes should not present any issues: 422, 423, and 507 (424 is also a new status code but it appears only in the body of a Multistatus response.) So, for example, if an HTTP client attempted to PUT or DELETE a locked resource, the 423 Locked response ought to result in a generic error presented to the user.

The 207 Multistatus response is interesting because an HTTP client issuing a DELETE request to a collection might interpret a 207 response as a success, even though it does not realize the resource is a collection and cannot understand that the DELETE operation might have been a complete or partial failure. That interpretation isn't entirely justified, because a 200-level response indicates that the server "received, understood, and accepted" the request, not that the request resulted in complete success.

One option is that a server could treat a DELETE of a collection as an atomic operation, and use either 204 No Content in case of success, or some appropriate error response (400 or 500 level) for an error. This approach would indeed maximize backward compatibility. However, since interoperability tests and working group discussions have not turned up any instances of HTTP clients issuing a DELETE request against a WebDAV collection, this concern is more theoretical than practical. Thus, servers are likely to be completely successful at interoperating with HTTP clients even if they treat any collection DELETE request as a WebDAV request and send a 207 Multi-Status response.

In general, server implementations are encouraged to use the detailed responses and other mechanisms defined in this document rather than make changes for theoretical interoperability concerns.

Appendix C. The 'opaquelocktoken' Scheme and URIs

The 'opaquelocktoken' URI scheme was defined in [RFC2518] (and registered by IANA) in order to create syntactically correct and easy-to-generate URIs out of UUIDs, intended to be used as lock tokens and to be unique across all resources for all time.

An opaquelocktoken URI is constructed by concatenating the 'opaquelocktoken' scheme with a UUID, along with an optional extension. Servers can create new UUIDs for each new lock token. If a server wishes to reuse UUIDs, the server MUST add an extension, and the algorithm generating the extension MUST guarantee that the same extension will never be used twice with the associated UUID.

```
OpaqueLockToken-URI = "opaquelocktoken:" UUID [Extension]
; UUID is defined in Section 3 of [RFC4122]. Note that LWS
; is not allowed between elements of
; this production.
```

```
Extension = path
; path is defined in Section 3.3 of [RFC3986]
```

Appendix D. Lock-null Resources

The original WebDAV model for locking unmapped URLs created "lock-null resources". This model was over-complicated and some interoperability and implementation problems were discovered. The new WebDAV model for locking unmapped URLs (see Section 7.3) creates "locked empty resources". Lock-null resources are deprecated. This section discusses the original model briefly because clients MUST be able to handle either model.

In the original "lock-null resource" model, which is no longer recommended for implementation:

- o A lock-null resource sometimes appeared as "Not Found". The server responds with a 404 or 405 to any method except for PUT, MKCOL, OPTIONS, PROPFIND, LOCK, UNLOCK.
- o A lock-null resource does however show up as a member of its parent collection.
- o The server removes the lock-null resource entirely (its URI becomes unmapped) if its lock goes away before it is converted to a regular resource. Recall that locks go away not only when they expire or are unlocked, but are also removed if a resource is renamed or moved, or if any parent collection is renamed or moved.

- o The server converts the lock-null resource into a regular resource if a PUT request to the URL is successful.
- o The server converts the lock-null resource into a collection if a MKCOL request to the URL is successful (though interoperability experience showed that not all servers followed this requirement).
- o Property values were defined for DAV:lockdiscovery and DAV:supportedlock properties but not necessarily for other properties like DAV:getcontenttype.

Clients can easily interoperate both with servers that support the old model "lock-null resources" and the recommended model of "locked empty resources" by only attempting PUT after a LOCK to an unmapped URL, not MKCOL or GET.

D.1. Guidance for Clients Using LOCK to Create Resources

A WebDAV client implemented to this specification might find servers that create lock-null resources (implemented before this specification using [RFC2518]) as well as servers that create locked empty resources. The response to the LOCK request will not indicate what kind of resource was created. There are a few techniques that help the client deal with either type.

If the client wishes to avoid accidentally creating either lock-null or empty locked resources, an "If-Match: *" header can be included with LOCK requests to prevent the server from creating a new resource.

If a LOCK request creates a resource and the client subsequently wants to overwrite that resource using a COPY or MOVE request, the client should include an "Overwrite: T" header.

If a LOCK request creates a resource and the client then decides to get rid of that resource, a DELETE request is supposed to fail on a lock-null resource and UNLOCK should be used instead. But with a locked empty resource, UNLOCK doesn't make the resource disappear. Therefore, the client might have to try both requests and ignore an error in one of the two requests.

Appendix E. Guidance for Clients Desiring to Authenticate

Many WebDAV clients that have already been implemented have account settings (similar to the way email clients store IMAP account settings). Thus, the WebDAV client would be able to authenticate with its first couple requests to the server, provided it had a way to get the authentication challenge from the server with realm name,

nonce, and other challenge information. Note that the results of some requests might vary according to whether or not the client is authenticated -- a PROPFIND might return more visible resources if the client is authenticated, yet not fail if the client is anonymous.

There are a number of ways the client might be able to trigger the server to provide an authentication challenge. This appendix describes a couple approaches that seem particularly likely to work.

The first approach is to perform a request that ought to require authentication. However, it's possible that a server might handle any request even without authentication, so to be entirely safe, the client could add a conditional header to ensure that even if the request passes permissions checks, it's not actually handled by the server. An example of following this approach would be to use a PUT request with an "If-Match" header with a made-up ETag value. This approach might fail to result in an authentication challenge if the server does not test authorization before testing conditionals as is required (see Section 8.5), or if the server does not need to test authorization.

Example - forcing auth challenge with write request

>>Request

```
PUT /forceauth.txt HTTP/1.1
Host: www.example.com
If-Match: "xxx"
Content-Type: text/plain
Content-Length: 0
```

The second approach is to use an Authorization header (defined in [RFC2617]), which is likely to be rejected by the server but which will then prompt a proper authentication challenge. For example, the client could start with a PROPFIND request containing an Authorization header containing a made-up Basic userid:password string or with actual plausible credentials. This approach relies on the server responding with a "401 Unauthorized" along with a challenge if it receives an Authorization header with an unrecognized username, invalid password, or if it doesn't even handle Basic authentication. This seems likely to work because of the requirements of RFC 2617:

"If the origin server does not wish to accept the credentials sent with a request, it SHOULD return a 401 (Unauthorized) response. The response MUST include a WWW-Authenticate header field containing at least one (possibly new) challenge applicable to the requested resource."

There's a slight problem with implementing that recommendation in some cases, because some servers do not even have challenge information for certain resources. Thus, when there's no way to authenticate to a resource or the resource is entirely publicly available over all accepted methods, the server MAY ignore the Authorization header, and the client will presumably try again later.

Example - forcing auth challenge with Authorization header

>>Request

```
PROPFIND /docs/ HTTP/1.1
Host: www.example.com
Authorization: Basic QWxhZGRpbjpvGVuIHNlc2FtZQ==
Content-type: application/xml; charset="utf-8"
Content-Length: xxxx
```

[body omitted]

Appendix F. Summary of Changes from RFC 2518

This section lists major changes between this document and RFC 2518, starting with those that are likely to result in implementation changes. Servers will advertise support for all changes in this specification by returning the compliance class "3" in the DAV response header (see Sections 10.1 and 18.3).

F.1. Changes for Both Client and Server Implementations

Collections and Namespace Operations

- o The semantics of PROPFIND 'allprop' (Section 9.1) have been relaxed so that servers return results including, at a minimum, the live properties defined in this specification, but not necessarily return other live properties. The 'allprop' directive therefore means something more like "return all properties that are supposed to be returned when 'allprop' is requested" -- a set of properties that may include custom properties and properties defined in other specifications if those other specifications so require. Related to this, 'allprop' requests can now be extended with the 'include' syntax to include specific named properties,

thereby avoiding additional requests due to changed 'allprop' semantics.

- o Servers are now allowed to reject PROPFIND requests with Depth: Infinity. Clients that used this will need to be able to do a series of Depth:1 requests instead.
- o Multi-Status response bodies now can transport the value of HTTP's Location response header in the new 'location' element. Clients may use this to avoid additional roundtrips to the server when there is a 'response' element with a 3xx status (see Section 14.24).
- o The definition of COPY has been relaxed so that it doesn't require servers to first delete the target resources anymore (this was a known incompatibility with [RFC3253]). See Section 9.8.

Headers and Marshalling

- o The Destination and If request headers now allow absolute paths in addition to full URIs (see Section 8.3). This may be useful for clients operating through a reverse proxy that does rewrite the Host request header, but not WebDAV-specific headers.
- o This specification adopts the error marshalling extensions and the "precondition/postcondition" terminology defined in [RFC3253] (see Section 16). Related to that, it adds the "error" XML element inside multistatus response bodies (see Section 14.5, however note that it uses a format different from the one recommended in RFC 3253).
- o Senders and recipients are now required to support the UTF-16 character encoding in XML message bodies (see Section 19).
- o Clients are now required to send the Depth header on PROPFIND requests, although servers are still encouraged to support clients that don't.

Locking

- o RFC 2518's concept of "lock-null resources" (LNRs) has been replaced by a simplified approach, the "locked empty resources" (see Section 7.3). There are some aspects of lock-null resources clients cannot rely on anymore, namely, the ability to use them to create a locked collection or the fact that they disappear upon UNLOCK when no PUT or MKCOL request was issued. Note that servers are still allowed to implement LNRs as per RFC 2518.

- o There is no implicit refresh of locks anymore. Locks are only refreshed upon explicit request (see Section 9.10.2).
- o Clarified that the DAV:owner value supplied in the LOCK request must be preserved by the server just like a dead property (Section 14.17). Also added the DAV:lockroot element (Section 14.12), which allows clients to discover the root of lock.

F.2. Changes for Server Implementations

Collections and Namespace Operations

- o Due to interoperability problems, allowable formats for contents of 'href' elements in multistatus responses have been limited (see Section 8.3).
- o Due to lack of implementation, support for the 'propertybehavior' request body for COPY and MOVE has been removed. Instead, requirements for property preservation have been clarified (see Sections 9.8 and 9.9).

Properties

- o Strengthened server requirements for storage of property values, in particular persistence of language information (xml:lang), whitespace, and XML namespace information (see Section 4.3).
- o Clarified requirements on which properties should be writable by the client; in particular, setting "DAV:displayname" should be supported by servers (see Section 15).
- o Only 'rfc1123-date' productions are legal as values for DAV:getlastmodified (see Section 15.7).

Headers and Marshalling

- o Servers are now required to do authorization checks before processing conditional headers (see Section 8.5).

Locking

- o Strengthened requirement to check identity of lock creator when accessing locked resources (see Section 6.4). Clients should be aware that lock tokens returned to other principals can only be used to break a lock, if at all.

- o Section 8.10.4 of [RFC2518] incorrectly required servers to return a 409 status where a 207 status was really appropriate. This has been corrected (Section 9.10).

F.3. Other Changes

The definition of collection state has been fixed so it doesn't vary anymore depending on the Request-URI (see Section 5.2).

The DAV:source property introduced in Section 4.6 of [RFC2518] was removed due to lack of implementation experience.

The DAV header now allows non-IETF extensions through URIs in addition to compliance class tokens. It also can now be used in requests, although this specification does not define any associated semantics for the compliance classes defined in here (see Section 10.1).

In RFC 2518, the definition of the Depth header (Section 9.2) required that, by default, request headers would be applied to each resource in scope. Based on implementation experience, the default has now been reversed (see Section 10.2).

The definitions of HTTP status code 102 ([RFC2518], Section 10.1) and the Status-URI response header (Section 9.7) have been removed due to lack of implementation.

The TimeType format used in the Timeout request header and the "timeout" XML element used to be extensible. Now, only the two formats defined by this specification are allowed (see Section 10.7).

Author's Address

Lisa Dusseault (editor)
CommerceNet
2064 Edgewood Dr.
Palo Alto, CA 94303
US

E-Mail: ldusseault@commerce.net

Full Copyright Statement

Copyright (C) The IETF Trust (2007).

This document is subject to the rights, licenses and restrictions contained in BCP 78, and except as set forth therein, the authors retain all their rights.

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY, THE IETF TRUST AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Intellectual Property

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in BCP 78 and BCP 79.

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at <http://www.ietf.org/ipr>.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at ietf-ipr@ietf.org.

Acknowledgement

Funding for the RFC Editor function is currently provided by the Internet Society.

