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Transparent Content Negotiation in HTTP

draft-ietf-http-negotiation-05.txt

STATUS OF THIS MEMO

ABSTRACT

HTTP allows web site authors to put multiple versions of the same information under a single URL. Transparent content negotiation is an extensible negotiation mechanism, layered on top of HTTP, for automatically selecting the best version when the URL is accessed. This enables the smooth deployment of

new web data formats and markup tags.

OVERVIEW OF THE TRANSPARENT CONTENT NEGOTIATION DOCUMENT SET

An up-to-date overview of documents related to transparent content negotiation is maintained on the web page <URL:http://gewis.win.tue.nl/~koen/conneg/>.

The transparent content negotiation document set currently consists of two series of internet drafts.

1. draft-ietf-http-negotiation-XX.txt (this document)

   `Transparent Content Negotiation in HTTP'

   Defines the core mechanism. Experimental track.

2. draft-ietf-http-rvsa-v10-XX.txt

   `HTTP Remote Variant Selection Algorithm -- RVSA/1.0'

   Defines the remote variant selection algorithm version 1.0. Experimental track.

Two related series of drafts are

3. draft-ietf-http-feature-reg-XX.txt

   `Feature Tag Registration Procedures'

   Defines feature tag registration. Best Current Practice track.

4. draft-ietf-http-feature-scenarios-XX.txt

   `Feature Tag Scenarios'

   Discusses feature tag scenarios. Informational track.

Another draft, defining a subset of transparent content negotiation wich is suitable for agent-driven negotiation, is

5. draft-ietf-http-alternates-XX.txt

   `The Alternates Header Field'

   Defines the Alternates header field. Experimental track.

An additional document about `the core feature set', which may

later become an informational RFC, may also appear. Currently, there are two internet drafts which discuss parts of what could be a core feature set: draft-mutz-http-attributes-XX.txt and draft-goland-http-headers-XX.txt

Older versions of the text in documents 1 and 2 may be found in the draft-holtman-http-negotiation-XX.txt series of internet drafts.

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1 Introduction

HTTP allows web site authors to put multiple versions of the same information under a single URI. Each of these versions is called a `variant'. Transparent content negotiation is an extensible negotiation mechanism for automatically and efficiently retrieving the best variant when a GET or HEAD request is made. This enables the smooth deployment of new web data formats and markup tags.

This specification defines transparent content negotiation as an extension on top of the HTTP/1.1 protocol [1]. However, use of this extension does not require use of HTTP/1.1: transparent content negotiation can also be done if some or all of the parties are HTTP/1.0 [3] systems.

Transparent content negotiation is called `transparent' because it makes all variants which exist inside the origin server visible to outside parties.

> Note: Though this specification is limited to negotiation on HTTP transactions, elements of this specification could also be used in other contexts. For example, feature predicates could be used in conditional HTML, and variant descriptions could be used in multipart mail messages. Such use in other contexts is encouraged.

1.1 Background

The addition of content negotiation to the web infrastructure has been considered important since the early days of the web. Among the expected benefits of a sufficiently powerful system for content negotiation are

* smooth deployment of new data formats and markup tags will allow graceful evolution of the web

* eliminating the need to choose between a `state of the art

multimedia homepage' and one which can be viewed by all web users

* enabling good service to a wider range of browsing platforms (from low-end PDA's to high-end VR setups)

* eliminating error-prone and cache-unfriendly User-Agent based negotiation

* enabling construction of sites without `click here for the X version' links

* internationalization, and the ability to offer multi-lingual content without a bias towards one language.

2 Terminology

The words "MUST", "MUST NOT", "SHOULD", "SHOULD NOT", and "MAY" in this document are to be interpreted as described in RFC 2119 [6].

This specification used the term `header' as an abbreviation for for `header field in a request or response message'.

2.1 Terms from HTTP/1.1

This specification mostly uses the terminology of the HTTP/1.1 specification [1]. The definitions below were reproduced from [1].

request
: An HTTP request message.

response
: An HTTP response message.

resource
: A network data object or service that can be identified by a URI. Resources may be available in multiple representations (e.g. multiple languages, data formats, size, resolutions) or vary in other ways.

content negotiation
: The mechanism for selecting the appropriate representation when servicing a request.

client
: A program that establishes connections for the purpose of sending requests.

user agent

The client which initiates a request. These are often browsers, editors, spiders (web-traversing robots), or other end user tools.

server
An application program that accepts connections in order to service requests by sending back responses. Any given program may be capable of being both a client and a server; our use of these terms refers only to the role being performed by the program for a particular connection, rather than to the program's capabilities in general. Likewise, any server may act as an origin server, proxy, gateway, or tunnel, switching behavior based on the nature of each request.

origin server
The server on which a given resource resides or is to be created.

proxy
An intermediary program which acts as both a server and a client for the purpose of making requests on behalf of other clients. Requests are serviced internally or by passing them on, with possible translation, to other servers. A proxy must implement both the client and server requirements of this specification.

age
The age of a response is the time since it was sent by, or successfully validated with, the origin server.

fresh
A response is fresh if its age has not yet exceeded its freshness lifetime.

2.2 New terms

transparently negotiable resource
A resource, identified by a single URI, which has multiple representations (variants) associated with it. When servicing a request on its URI, it allows selection of the best representation using the transparent content negotiation mechanism. A transparently negotiable resource always has a variant list bound to it, which can be represented as an Alternates header (defined in section 8.3).

variant list
A list containing variant descriptions, which can be bound to a transparently negotiable resource.

variant description
A machine-readable description of a variant resource, usually

found in a variant list. A variant description contains the variant resource URI and various attributes which describe properties of the variant. Variant descriptions are defined in section 5.

variant resource
: A resource from which a variant of a negotiable resource can be retrieved with a normal HTTP/1.x GET request, i.e. a GET request which does not use transparent content negotiation.

neighboring variant
: A variant resource is called a neighboring variant resource of some transparently negotiable HTTP resource if the variant resource has a HTTP URL, and if the absolute URL of the variant resource up to its last slash equals the absolute URL of the negotiable resource up to its last slash, where equality is determined with the URI comparison rules in section 3.2.3 of [1]. The property of being a neighboring variant is important because of security considerations (section 14.2). Not all variants of a negotiable resource need to be neighboring variants. However, access to neighboring variants can be more highly optimized by the use of remote variant selection algorithms (section 7) and choice responses (section 10.2).

remote variant selection algorithm
: A standardized algorithm by which a server can sometimes choose a best variant on behalf of a negotiating user agent. The algorithm typically computes whether the Accept- headers in the request contain sufficient information to allow a choice, and if so, which variant is the best variant. The use of a remote algorithm can speed up the negotiation process.

list response
: A list response returns the variant list of the negotiable resource, but no variant data. It can be generated when the server does not want to, or is not allowed to, return a particular best variant for the request. List responses are defined in section 10.1.

choice response
: A choice response returns a representation of the best variant for the request, and may also return the variant list of the negotiable resource. It can be generated when the server has sufficient information to be able to choose the best variant on behalf the user agent, but may only be generated if this best variant is a neighboring variant. Choice responses are defined in section 10.2.

adhoc response
: An adhoc response can be sent by an origin server as an extreme measure, to achieve compatibility with a non-negotiating or buggy

client if this compatibility cannot be achieved by sending a list or choice response. There are very little requirements on the contents of an adhoc response. Adhoc responses are defined in section 10.3.

Accept- headers
: The request headers: Accept, Accept-Charset, Accept-Language, and Accept-Features.

supports transparent content negotiation
: From the viewpoint of an origin server or proxy, a user agent supports transparent content negotiation if and only if it sends a Negotiate header (section 8.4) which indicates such support.

server-side override
: If a request on a transparently negotiated resource is made by a client which supports transparent content negotiation, an origin server is said to perform a server-side override if the server ignores the directives in the Negotiate request header, and instead uses a custom algorithm to choose an appropriate response. A server-side override can sometimes be used to work around known client bugs. It could also be used by protocol extensions on top of transparent content negotiation.

3 Notation

The version of BNF used in this document is taken from [1], and many of the nonterminals used are defined in [1].

One new BNF construct is added:

```
   1%rule
```

stands for one or more instances of "rule", separated by whitespace:

```
   1%rule =  rule *( 1*LWS rule )
```

This specification also introduces

```
  number = 1*DIGIT

  short-float = 1*3DIGIT [ "." 0*3DIGIT ]
```

This specification uses the same conventions as in [1] (see section 1.2 of [1]) for defining the significance of each particular requirement.

4 Overview

This section gives an overview of transparent content negotiation. It starts with a more general discussion of negotiation as provided by HTTP.

4.1 Content negotiation

HTTP/1.1 allows web site authors to put multiple versions of the same information under a single resource URI. Each of these versions is called a `variant'. For example, a resource http://x.org/paper could bind to three different variants of a paper:

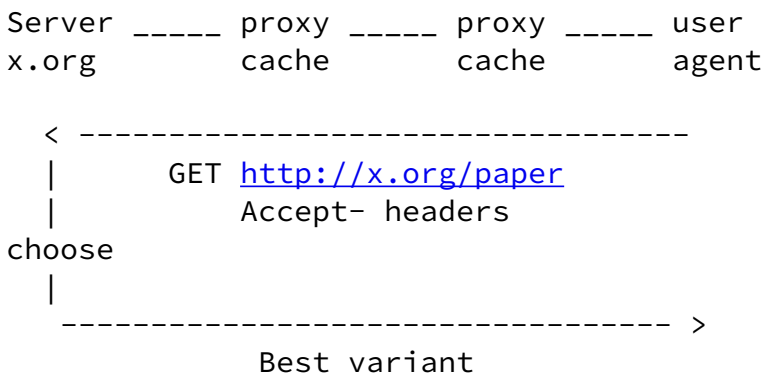
1. HTML, English
2. HTML, French
3. Postscript, English

Content negotiation is the process by which the best variant is selected if the resource is accessed. The selection is done by matching the properties of the available variants to the capabilities of the user agent and the preferences of the user.

It has always been possible under HTTP to have multiple representations available for one resource, and to return the most appropriate representation for each subsequent request. However, HTTP/1.1 is the first version of HTTP which has provisions for doing this in a cache-friendly way. These provisions include the Vary response header, entity tags, and the If-None-Match request header.

4.2 HTTP/1.0 style negotiation scheme

The HTTP/1.0 protocol elements allow for a negotiation scheme as follows:



When the resource is accessed, the user agent sends (along with its request) various Accept- headers which express the user agent capabilities and the user preferences. Then the origin server uses these Accept- headers to choose the best variant, which is returned

in the response.

The biggest problem with this scheme is that it does not scale well. For all but the most minimal user agents, Accept- headers expressing all capabilities and preferences would be very large, and sending them in every request would be hugely inefficient, in particular because only a small fraction of the resources on the web have multiple variants.

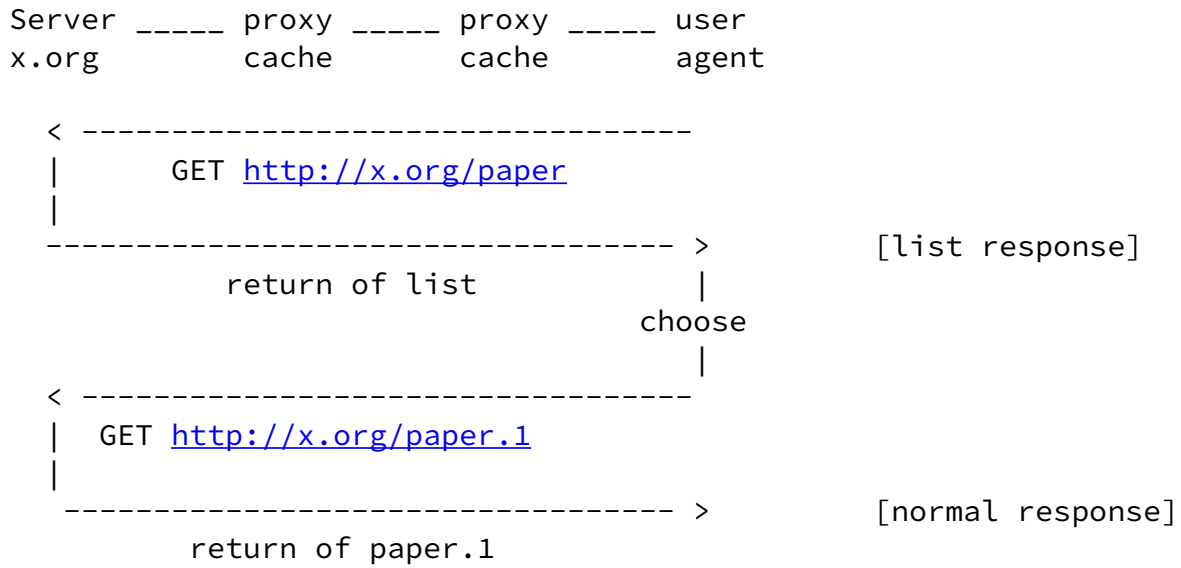
4.3 Transparent content negotiation scheme

The transparent content negotiation scheme eliminates the need to send huge Accept- headers, and nevertheless allows for a selection process that always yields either the best variant, or an error message indicating that user agent is not capable of displaying any of the available variants.

Under the transparent content negotiation scheme, the server sends a list with the available variants and their properties to the user agent. An example of a list with three variants is

```
{"paper.1" 0.9 {type text/html} {language en}},
{"paper.2" 0.7 {type text/html} {language fr}},
{"paper.3" 1.0 {type application/postscript} {language en}}
```

The syntax and semantics of the variant descriptions in this list are covered in section 5. When the list is received, the user agent can choose the best variant and retrieve it. Graphically, the communication can be represented as follows:



The first response returning the list of variants is called a `list response'. The second response is a normal HTTP response: it does not contain special content negotiation related information. Only the user agent needs to know that the second request actually

retrieves a variant. For the other parties in the communication, the second transaction is indistinguishable from a normal HTTP transaction.

With this scheme, information about capabilities and preferences is only used by the user agent itself. Therefore, sending such information in large Accept- headers is unnecessary. Accept- headers do have a limited use in transparent content negotiation however; the sending of small Accept- headers can often speed up the negotiation process. This is covered in section 4.4.

List responses are covered in section 10.1. As an example, the list response in the above picture could be:

```
HTTP/1.1 300 Multiple Choices
Date: Tue, 11 Jun 1996 20:02:21 GMT
TCN: list
Alternates: {"paper.1" 0.9 {type text/html} {language en}},
            {"paper.2" 0.7 {type text/html} {language fr}},
            {"paper.3" 1.0 {type application/postscript}
                {language en}}
Vary: negotiate, accept, accept-language
ETag: "blah;1234"
Cache-control: max-age=86400
Content-Type: text/html
Content-Length: 227

<h2>Multiple Choices:</h2>
<ul>
<li><a href=paper.1>HTML, English version</a>
<li><a href=paper.2>HTML, French version</a>
<li><a href=paper.3>Postscript, English version</a>
</ul>
```

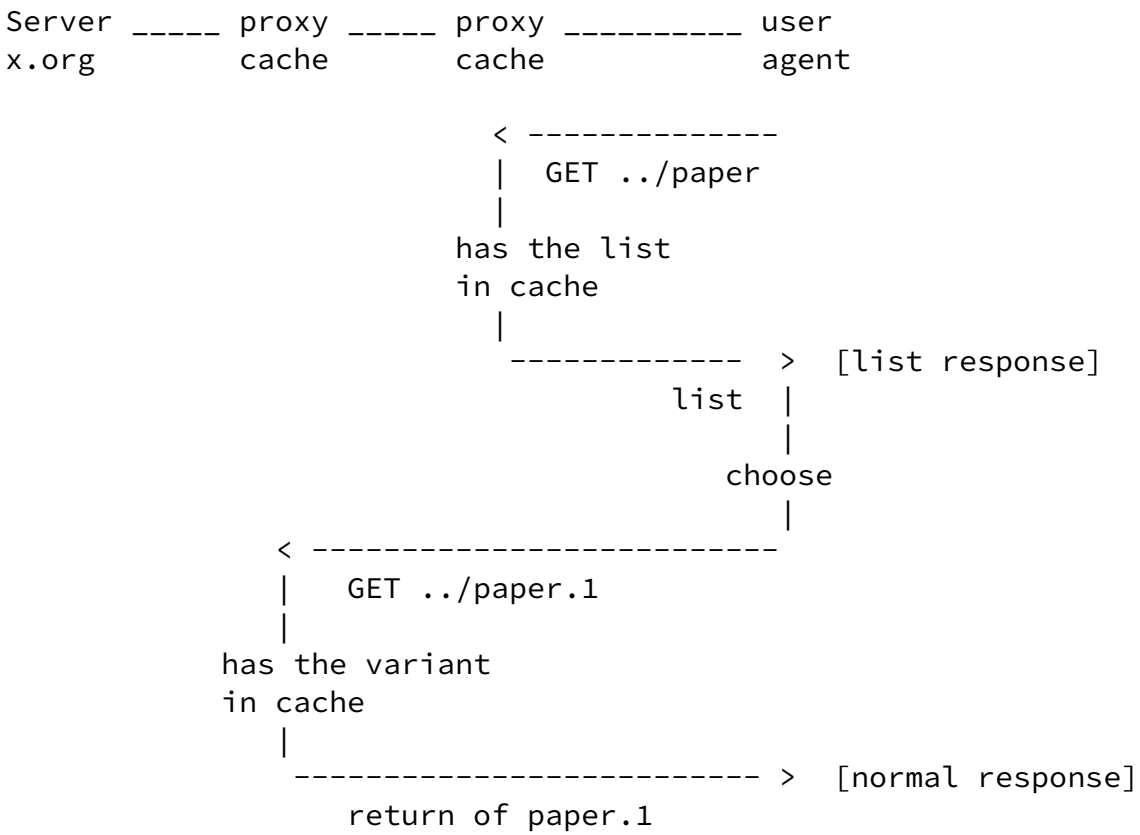
The Alternates header in the response contains the variant list. The Vary header is included to ensure correct caching by plain HTTP/1.1 caches (see section 10.6). The ETag header allows the response to be revalidated by caches, the Cache-Control header controls this revalidation. The HTML entity included in the response allows the user to select the best variant by hand if desired.

4.4 Optimizing the negotiation process

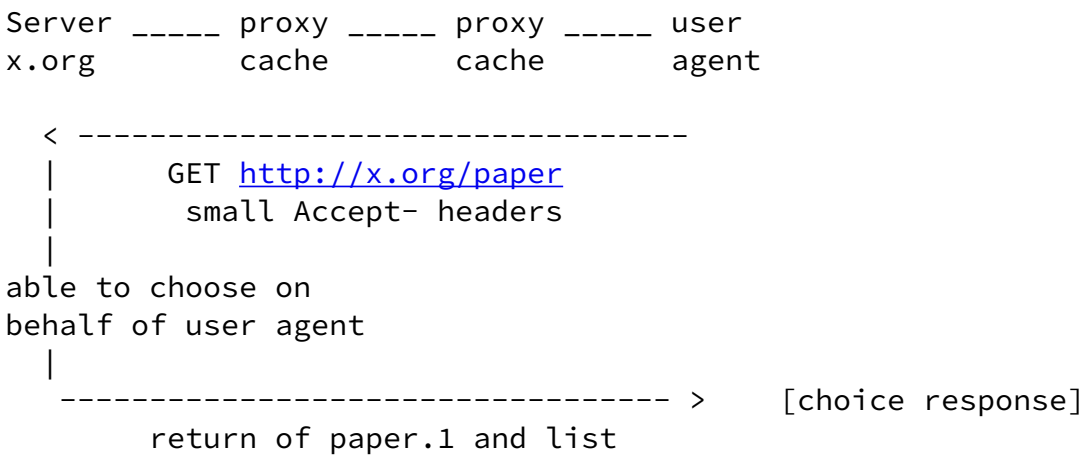
The basic transparent negotiation scheme involves two HTTP transactions: one to retrieve the list, and a second one to retrieve the chosen variant. There are however several ways to `cut corners' in the data flow path of the basic scheme.

First, caching proxies can cache both variant lists and variants.

Such caching can reduce the communication overhead, as shown in the following example:



Second, the user agent can send small Accept- headers, which may contain enough information to allow the server to choose the best variant and return it directly.



This choosing based on small Accept- headers is done with a `remote variant selection algorithm'. Such an algorithm takes the variant list and the Accept- headers as input. It then computes whether the Accept- headers contain sufficient information to choose on behalf of the user agent, and if so, which variant is the best variant. If the best variant is a neighboring variant, it may be returned, together with the variant list, in a choice response.

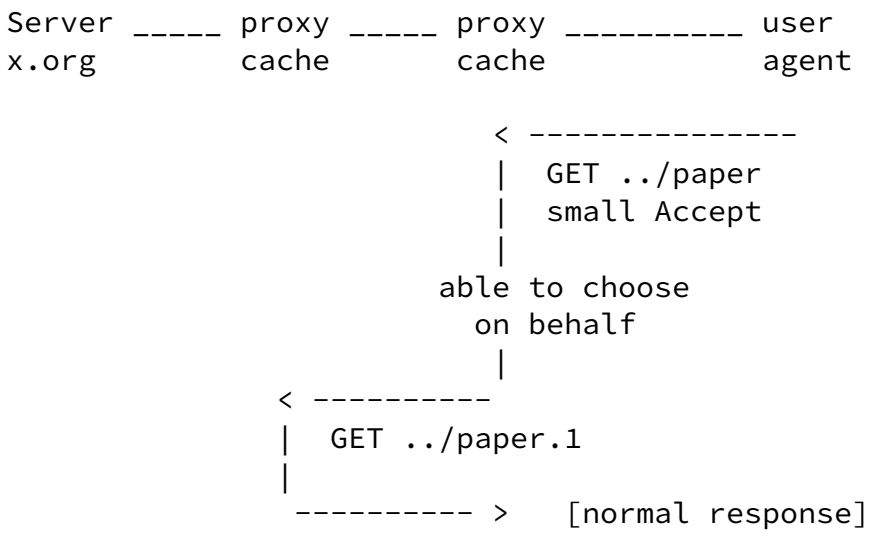
A server may only choose on behalf of a user agent supporting transparent content negotiation if the user agent explicitly allows the use of a particular remote variant selection algorithm in the Negotiate request header. User agents with sophisticated internal variant selection algorithms may want to disallow a remote choice, or may want to allow it only when retrieving inline images. If the local algorithm of the user agent is superior in only some difficult areas of negotiation, it is possible to enable the remote algorithm for the easy areas only. More information about the use of a remote variant selection algorithm can be found in [5].

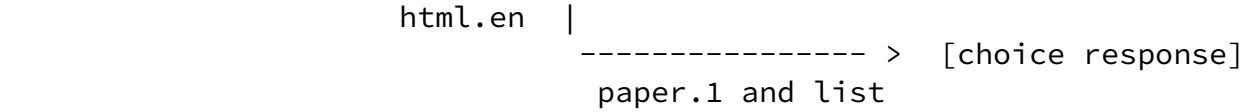
Choice responses are covered in section 10.2. For example, the choice response in the above picture could be:

```
HTTP/1.1 200 OK
Date: Tue, 11 Jun 1996 20:05:31 GMT
TCN: choice
Content-Type: text/html
Last-Modified: Mon, 10 Jun 1996 10:01:14 GMT
Content-Length: 5327
Cache-control: max-age=604800
Content-Location: paper.1
Alternates: {"paper.1" 0.9 {type text/html} {language en}},
            {"paper.2" 0.7 {type text/html} {language fr}},
            {"paper.3" 1.0 {type application/postscript}
                {language en}}
Etag: "gonkyyyy;1234"
Vary: negotiate, accept, accept-language
Expires: Thu, 01 Jan 1980 00:00:00 GMT

<title>A paper about ....
```

Finally, the above two kinds of optimization can be combined; a caching proxy which has the list will sometimes be able to choose on behalf of the user agent. This could lead to the following communication pattern:





Note that this cutting of corners not only saves bandwidth, it also eliminates delays due to packet round trip times, and reduces the load on the origin server.

4.5 Downwards compatibility with non-negotiating user agents

To handle requests from user agents which do not support transparent content negotiation, this specification allows the origin server to revert to a HTTP/1.0 style negotiation scheme. The specification of heuristics for such schemes is beyond the scope of this document.

4.6 Retrieving a variant by hand

It is always possible for a user agent to retrieve the variant list which is bound to a negotiable resource. The user agent can use this list to make available a menu of all variants and their characteristics to the user. Such a menu allows the user to randomly browse other variants, and makes it possible to manually correct any sub-optimal choice made by the automatic negotiation process.

4.7 Dimensions of negotiation

Transparent content negotiation defines four dimensions of negotiation:

1. Media type (MIME type)
2. Charset
3. Language
4. Features

The first three dimensions have traditionally been present in HTTP. The fourth dimension is added by this specification. Additional dimensions, beyond the four mentioned above, could be added by future specifications.

Negotiation on the content encoding of a response (gzipped, compressed, etc.) is left outside of the realm of transparent negotiation. See section 10.8 for more information.

4.8 Feature negotiation

Feature negotiation intends to provide for all areas of negotiation not covered by the type, charset, and language dimensions. Examples are negotiation on

* HTML extensions
* Extensions of other media types
* Color capabilities of the user agent
* Screen size
* Output medium (screen, paper, ...)
* Preference for speed vs. preference for graphical detail

The feature negotiation framework (section 6) is the principal means by which transparent negotiation offers extensibility; a new dimension of negotiation (really a sub-dimension of the feature dimension) can be added without the need for a new standards effort by the simple registration of a `feature tag'. Feature tag registration is discussed in [4].

4.9 Length of variant lists

As a general rule, variant lists should be short: it is expected that a typical transparently negotiable resource will have 2 to 10 variants, depending on its purpose. Variant lists should be short for a number of reasons:

1. The user must be able to pick a variant by hand to correct a bad automatic choice, and this is more difficult with a long variant list.

2. A large number of variants will decrease the efficiency of internet proxy caches.

3. Long variant lists will make some transparently negotiated responses longer.

In general, it is not desirable to create a transparently negotiable resource with hundreds of variants in order to fine-tune the graphical presentation of a resource. Any graphical fine-tuning should be done, as much as possible, by using constructs which act at the user agent side, for example

```
<center><img src=titlebanner.gif width=100%
alt="MegaBozo Corp"></center>
```

In order to promote user agent side fine tuning, which is more scalable than fine tuning over the network, user agents which implement a scripting language for content rendering are encouraged to make the availability of this language visible for transparent content negotiation, and to allow rendering scripts to access the capabilities and preferences data used for content negotiation, as

far as privacy considerations permit this.

4.10 Relation with other negotiation schemes

The HTTP/1.x protocol suite allows for many different negotiation mechanisms. Transparent content negotiation specializes in scalable, interoperable negotiation of content representations at the HTTP level. It is intended that transparent negotiation will co-exist with other negotiation schemes, both open and proprietary, which cover different application domains or work at different points in the author-to-user chain. Ultimately, it will be up to the resource author to decide which negotiation mechanism, or combination of negotiation mechanisms, is most appropriate for the task at hand.

This specification explicitly encourages future negotiation mechanisms to re-use parts of this specification when appropriate. With respect to re-use, two parts of this specification are particularly important:

1. the syntax and semantics of variant descriptions (section 5-6)

2. the transport and caching protocol for negotiated data (section 8-10)

5 Variant descriptions

5.1 Syntax

A variant can be described in a machine-readable way with a variant description.

```
variant-description =
           "{" <"> URI <"> source-quality *variant-attribute"}"

source-quality = qvalue

variant-attribute = "{" "type" media-type "}"
                  | "{" "charset" charset "}"
                  | "{" "language"  1#language-tag "}"
                  | "{" "length" 1*DIGIT "}"
                  | "{" "features" feature-list "}"
                  | "{" "description" quoted-string "}"
                  | extension-attribute

extension-attribute = "{" extension-name extension-value "}"
extension-name      = token
extension-value     = *( token | quoted-string | LWS
                       | extension-specials )
```

```
    extension-specials  =
                        <any element of tspecials except <"> and "}">
```

The feature-list syntax is defined in section 6.4.

Examples are

```
{"paper.2" 0.7 {type text/html} {language fr}}

{"paper.5" 0.9 {type text/html} {features tables}}

{"paper.1" 0.001}
```

The various attributes which can be present in a variant description are covered in the subsections below. Each attribute may appear only once in a variant description.

5.2 URI

The URI attribute gives the URI of the resource from which the variant can be retrieved with a GET request. It can be absolute or relative to the Request-URI. The variant resource may vary (on the Cookie request header, for example), but MUST NOT engage in transparent content negotiation itself.

5.3 Source-quality

The source-quality attribute gives the quality of the variant, as a representation of the negotiable resource, when this variant is rendered with a perfect rendering engine on the best possible output medium.

If the source-quality is less than 1, it often expresses a quality degradation caused by a lossy conversion to a particular data format. For example, a picture originally in JPEG form would have a lower source quality when translated to the XBM format, and a much lower source quality when translated to an ASCII-art variant. Note however, that degradation is a function of the source; an original piece of ASCII-art may degrade in quality if it is captured in JPEG form.

The source-quality could also represent a level of quality caused by skill of language translation, or ability of the used media type to capture the intended artistic expression.

Servers should use the following table a guide when assigning source quality values:

```
1.000  perfect representation
0.900  threshold of noticeable loss of quality
0.800  noticeable, but acceptable quality reduction
0.500  barely acceptable quality
0.300  severely degraded quality
0.000  completely degraded quality
```

The same table can be used by local variant selection algorithms (see appendix 18) when assigning degradation factors for different content rendering mechanisms. Note that most meaningful values in this table are close to 1. This is due to the fact that quality factors are generally combined by multiplying them, not by adding them.

When assigning source-quality values, servers should not account for the size of the variant and its impact on transmission and rendering delays; the size of the variant should be stated in the length attribute and any size-dependent calculations should be done by the variant selection algorithm. Any constant rendering delay for a particular media type (for example due to the startup time of a helper application) should be accounted for by the user agent, when assigning a quality factor to that media type.

5.4 Type, charset, language, and length

The type attribute of a variant description carries the same information as its Content-Type response header counterpart defined in [1], except for any charset information, which MUST be carried in the charset attribute. For, example, the header

```
Content-Type: text/html; charset=ISO-8859-4
```

has the counterpart attributes

```
{type text/html} {charset ISO-8859-4}
```

The language and length attributes carry the same information as their Content-* response header counterparts in [1]. The length attribute, if present, MUST thus reflect the length of the variant alone, and not the total size of the variant and any objects inlined or embedded by the variant.

Though all of these attributes are optional, it is often desirable to include as many attributes as possible, as this will increase the quality of the negotiation process.

> Note: A server is not required to maintain a one-to-one correspondence between the attributes in the variant description and the Content-* headers in the variant response. For example, if the variant description contains a language attribute, the

response does not necessarily have to contain a Content-Language header. If a Content-Language header is present, it does not have to contain an exact copy of the information in the language attribute.

5.5 Features

The features attribute specifies how the presence or absence of particular feature tags in the user agent affects the overall quality of the variant. This attribute is covered in section 6.4.

5.6 Description

The description attribute gives a textual description of the variant. It can be included if the URI and normal attributes of a variant are considered too opaque to allow interpretation by the user. If a user agent is showing a menu of available variants compiled from a variant list, and if a variant has a description attribute, the user agent SHOULD show the description attribute of the variant instead of showing the normal attributes of the variant. The description field uses the UTF-8 character encoding scheme [7], which is a superset of US-ASCII, with ""%" HEX HEX" encoding.

5.7 Extension-attribute

The extension-attribute allows future specifications to incrementally define dimensions of negotiation which cannot be created by using the feature negotiation framework, and eases content negotiation experiments. In experimental situations, servers MUST ONLY generate extension-attributes whose names start with "x-". User agents SHOULD ignore all extension attributes they do not recognize. Proxies MUST NOT run a remote variant selection algorithm if an unknown extension attribute is present in the variant list.

6 Feature negotiation

This section defines the feature negotiation mechanism. Feature negotiation has been introduced in section 4.8. Appendix 19 contains examples of feature negotiation.

6.1 Feature tags

A feature tag (ftag) identifies something which can be negotiated on, for example a property (feature) of a representation, a

capability (feature) of a user agent, or the preference of a user for a particular type of representation. The use of feature tags need not be limited to transparent content negotiation, and not every feature tag needs to be usable in the HTTP transparent content negotiation framework.

```
ftag = token | quoted-string
```

Note: A system for feature tag registration is currently being developed in the IETF [4]. This specification does not define any feature tags. In experimental situations, the use of tags which start with "x." is encouraged.

Feature tags are used in feature sets (section 6.2) and in feature predicates (section 6.3). Feature predicates are in turn used in features attributes (section 6.4), which are used in variant descriptions (section 5). Variant descriptions can be transmitted in Alternates headers (section 8.3).

Feature tag comparison is case-insensitive. A token tag XYZ is equal to a quoted-string tag "XYZ". Examples are

```
tables, fonts, blebber, wolx, screenwidth, colordepth
```

An example of the use of feature tags in a variant description is:

```
{"index.html" 1.0 {type text/html} {features tables frames}}
```

This specification follows general computing practice in that it places no restrictions on what may be called a feature. Feature tag definitions SHOULD describe the tag from the viewpoint of the variant author. For example, a definition could start with `the X feature tag labels variants which are intended for...'.

At the protocol level, this specification does not distinguish between different uses of feature tags: a tag will be processed in the same way, no matter whether it identifies a property, capability, or preference. For some tags, it may be fluid whether the tag represents a property, preference, or capability. For example, in content negotiation on web pages, a "textonly" tag would identify a capability of a text-only user agent, but the user of a graphical user agent may use this tag to specify that text-only content is preferred over graphical content.

While the usage of some tags may be fluid, it is expected that other tag definitions will strictly limit the usage of a tag to expressing a property, capability, or preference only. However, the protocol does not contain any facilities which could enforce such limitations.

6.1.1 Feature tag values

The definition of a feature tag may state that a feature tag can have zero, one, or more values associated with it. These values specialize the meaning of the tag. For example, a feature tag `paper' could be associated with the values `A4' and `A5'.

```
tag-value  = token | quoted-string
```

Equality comparison for tag values MUST be done with a case-sensitive, octet-by-octet comparison, where any ""%" HEX HEX" encodings MUST be processed as in [1]. A token value XYZ is equal to a quoted-string value "XYZ".

6.2 Feature sets

The feature set of a user agent is a data structure which records the capabilities of the user agent and the preferences of the user.

Feature sets are used by local variant selection algorithms (see appendix 18 for an example). A user agent can use the Accept-Features header (section 8.2) to make some of the contents of its feature set known to remote variant selection algorithms.

Structurally, a feature set is a possibly empty set, containing records of the form

```
( feature tag , set of feature tag values )
```

If a record with a feature tag is present in the set, this means that the user agent implements the corresponding capability, or that the user has expressed the corresponding preference.

Each record in a feature set has a, possibly empty, set of tag values. For feature tags which cannot have values associated with it, this set is always empty. For feature tags which can have zero, one, or more values associated with it, this set contains those values currently associated with the tag. If the set of a featue tag T has the value V in it, it is said that `the tag T is present with the value V'.

This specification does not define a standard notation for feature sets. An example of a very small feature set, in a mathematical notation, is

```
{ ( "frames" , { } ) ,
  ( "paper"  , { "A4" , "A5" } )
}
```

As feature registration [4] will be an ongoing process, it is generally not possible for a user agent to know the meaning of all

feature tags it can possibly encounter in a variant description. A user agent SHOULD treat all features tags unknown to it as absent from its feature set.

A user agent may change the contents of its feature set depending on the type of request, and may also update it to reflect changing conditions, for example a change in the window size. Therefore, when considering feature negotiation, one usually talks about `the feature set of the current request'.

6.3 Feature predicates

Feature predicates are predicates on the contents of feature sets. They appear in the features attribute of a variant description.

```
fpred = [ "!" ] ftag
      | ftag ( "=" | "!=" ) tag-value
      | ftag "=" "[" numeric-range "]"

numeric-range = [ number ] "-" [ number ]
```

Feature predicates are used in features attributes (section 6.4), which are used in variant descriptions (section 5). Variant descriptions can be transmitted in Alternates headers (section 8.3).

Examples of feature predicates are

```
blebber, !blebber, paper=a4, colordepth=5, blex!=54,
dpi=[300-599], colordepth=[24-]
```

Using the feature set of the current request, a user agent SHOULD compute the truth value of the different feature predicates as follows.

ftag	true if the feature is present, false otherwise
!ftag	true if the feature is absent, false otherwise
ftag=V	true if the feature is present with the value V, false otherwise,
ftag!=V	true if the feature is not present with the value V, false otherwise,
ftag=[N-M]	true if the feature is present with at least one numeric value, while the highest value with which it is present in the range N-M, false otherwise. If N is missing, the lower bound is 0. If M is missing, the upper bound is infinity.

As an example, with the feature set

```
{ ( "blex"       , { } ),
  ( "colordepth" , { "5" } ),
  ( "UA-media"   , { "stationary" } ),
  ( "paper"      , { "A4", "A3" } ) ,
  ( "x-version"  , { "104", "200" } )
}
```

the following predicates are true:

```
blex, colordepth=[4-], colordepth!=6, colordepth, !screenwidth,
UA-media=stationary, UA-media!=screen, paper=A4, paper =!A0,
colordepth=[ 4 - 6 ], x-version=[100-300], x-version=[200-300]
```

and the following predicates are false:

```
!blex, blebber, colordepth=6, colordepth=foo, !colordepth,
screenwidth, screenwidth=640, screenwidth!=640, x-version=99,
UA-media=screen, paper=A0, paper=a4, x-version=[100-199], wuxta
```

6.4 Features attribute

The features attribute, for which section 5.1 defines the syntax

```
"{" "features" feature-list "}"
```

is used in a variant description to specify how the presence or absence of particular feature tags in the user agent affects the overall quality of the variant.

```
feature-list = 1%feature-list-element

feature-list-element = ( fpred | fpred-bag )
                       [ ";" [ "+" true-improvement  ]
                             [ "-" false-degradation ]
                       ]

fpred-bag = "[" 1%fpred "]"

true-improvement   =  short-float
false-degradation  =  short-float
```

Features attributes are used in variant descriptions (section 5). Variant descriptions can be transmitted in Alternates headers (section 8.3).

Examples are:

```
{features !textonly [blebber !wolx] colordepth=3;+0.7}

{features !blink;-0.5 background;+1.5 [blebber !wolx];+1.4-0.8}
```

The default value for the true-improvement is 1. The default value for the false-degradation is 0, or 1 if a true-improvement value is given.

A user agent SHOULD, and a remote variant selection algorithm MUST compute the quality degradation factor associated with the features attribute by multiplying all quality degradation factors of the elements of the feature-list. Note that the result can be a factor greater than 1.

A feature list element yields its true-improvement factor if the corresponding feature predicate is true, or if at least one element of the corresponding fpred-bag is true. The element yields its false-degradation factor otherwise.

7 Remote variant selection algorithms

A remote variant selection algorithm is a standardized algorithm by which a server can choose a best variant on behalf of a negotiating user agent. The use of a remote algorithm can speed up the negotiation process by eliminating a request-response round trip.

A remote algorithm typically computes whether the Accept- headers in the request contain sufficient information to allow a choice, and if so, which variant is the best variant. This specification does not define any remote algorithms, but does define a mechanism to negotiate on the use of such algorithms.

7.1 Version numbers

A version numbering scheme is used to distinguish between different remote variant selection algorithms.

```
rvsa-version = major "." minor

major = 1*4DIGIT
minor = 1*4DIGIT
```

An algorithm with the version number X.Y, with Y>0, MUST be downwards compatible with all algorithms from X.0 up to X.Y. Downwards compatibility means that, if supplied with the same information, the newer algorithm MUST make the same choice, or a better choice, as the old algorithm. There are no compatibility requirements between algorithms with different major version

numbers.

8 Content negotiation status codes and headers

This specification adds one new HTTP status code, and introduces six new HTTP headers. It also extends the semantics of an existing HTTP/1.1 header.

8.1 506 Variant Also Negotiates

The 506 status code indicates that the server has an internal configuration error: the chosen variant resource is configured to engage in transparent content negotiation itself, and is therefore not a proper end point in the negotiation process.

8.2 Accept-Features

The Accept-Features request header can be used by a user agent to give information about the presence or absence of certain features in the feature set of the current request. Servers can use this information when running a remote variant selection algorithm.

> Note: the name `Accept-Features' for this header was chosen because of symmetry considerations with other Accept- headers, even though the Accept-Features header will generally not contain an exhaustive list of features which are somehow `accepted'. A more accurate name of this header would have been `Feature-Set-Info'.

```
Accept-Features = "Accept-Features" ":"
                  #( feature-expr *( ";" feature-extension ) )

feature-expr = [ "!" ] ftag
               | ftag ( "=" | "!=" ) tag-value
               | ftag "=" "{" tag-value "}"
               | "*"

feature-extension = token [ "=" ( token | quoted-string ) ]
```

No feature extensions are defined in this specification. An example is:

```
Accept-Features: blex, !blebber, colordepth={5}, !screenwidth,
                 paper = A4, paper!="A2", x-version=104, *
```

The different feature expressions have the following meaning:

> ftag ftag is present

!ftag	ftag is absent
ftag=V	ftag is present with the value V
ftag!=V	ftag is present, but not with the value V
ftag={V}	ftag is present with the value V, and not with any other values
*	the expressions in this header do not fully describe the feature set: feature tags not mentioned in this header may also be present, and, except for the case ftag={V}, tags may be present with more values than mentioned.

Absence of the Accept-Features header in a request is equivalent to the inclusion of

```
Accept-Features: *
```

By using the Accept-Features header, a remote variant selection algorithm can sometimes determine the truth value of a feature predicate on behalf of the user agent. For example, with the header

```
Accept-Features: blex, !blebber, colordepth={5}, !screenwidth,
           paper = A4, paper!="A2", x-version=104, *
```

the algorithm can determine that the following predicates are true:

```
blex, colordepth=[4-], colordepth!=6, colordepth, !screenwidth,
paper=A4, colordepth=[4-6]
```

and that the following predicates are false:

```
!blex, blebber, colordepth=6, colordepth=foo, !colordepth,
screenwidth, screenwidth=640, screenwidth!=640,
```

but the truth value of the following predicates cannot be determined:

```
UA-media=stationary, UA-media!=screen, paper!=a0,
x-version=[100-300], x-version=[200-300], x-version=99,
UA-media=screen, paper=A0, paper=a4, x-version=[100-199], wuxta
```

8.3 Alternates

The Alternates response header is used to convey the list of variants bound to a negotiable resource. This list can also

include directives for any content negotiation process. If a response from a transparently negotiable resource includes an Alternates header, this header MUST contain the complete variant list bound to the negotiable resource. Responses from resources which do not support transparent content negotiation MAY also use Alternates headers.

```
    Alternates = "Alternates" ":" variant-list

    variant-list = 1#( variant-description
                     | fallback-variant
                     | list-directive )

    fallback-variant = "{" <"> URI <"> "}"

    list-directive = ( "proxy-rvsa" "=" <"> 0#rvsa-version <"> )
                     | extension-list-directive

    extension-list-directive =
                     token [ "=" ( token | quoted-string ) ]
```

An example is

```
  Alternates: {"paper.1" 0.9 {type text/html} {language en}},
              {"paper.2" 0.7 {type text/html} {language fr}},
              {"paper.3" 1.0 {type application/postscript}
                  {language en}},
              proxy-rvsa="1.0, 2.5"
```

Any relative URI specified in a variant-description or fallback-variant field is relative to the request-URI. Only one fallback-variant field may be present. If the variant selection algorithm of the user agent finds that all described variants are unacceptable, then it SHOULD choose the fallback variant, if present, as the best variant. If the user agent computes the overall quality values of the described variants, and finds that several variants share the highest value, then the first variant with this value in the list SHOULD be chosen as the best variant.

The proxy-rvsa directive restricts the use of remote variant selection algorithms by proxies. If present, a proxy MUST ONLY use algorithms which have one of the version numbers listed, or have the same major version number and a higher minor version number as one of the versions listed. Any restrictions set by proxy-rvsa come on top of the restrictions set by the user agent in the Negotiate request header. The directive proxy-rvsa="" will disable variant selection by proxies entirely. Clients SHOULD ignore all extension-list-directives they do not understand.

A variant list may contain multiple differing descriptions of the same variant. This can be convenient if the variant uses

conditional rendering constructs, or if the variant resource returns multiple representations using a multipart media type.

8.4 Negotiate

The Negotiate request header can contain directives for any content negotiation process initiated by the request.

```
Negotiate = "Negotiate" ":" 1#negotiate-directive

negotiate-directive = "trans"
                    | "vlist"
                    | "guess-small"
                    | rvsa-version
                    | "*"
                    | negotiate-extension

negotiate-extension = token [ "=" token ]
```

Examples are

```
Negotiate: 1.0, 2.5
Negotiate: *
```

The negotiate directives have the following meaning

"trans"
: The user agent supports transparent content negotiation for the current request.

"vlist"
: The user agent requests that any transparently negotiated response for the current request includes an Alternates header with the variant list bound to the negotiable resource. Implies "trans".

"guess-small"
: The user agent allows origin servers to run a custom algorithm which guesses the best variant for the request, and to return this variant in a choice response, if the resulting choice response is smaller than or not much larger than a list response. The definition of `not much larger' is left to origin server heuristics. Implies "vlist" and "trans".

rvsa-version
: The user agent allows origin servers and proxies to run the remote variant selection algorithm with the indicated version number, or with the same major version number and a higher minor version number. If the algorithm has sufficient information to choose a best, neighboring variant, the origin

server or proxy MAY return a choice response with this variant. Implies "trans".

"*"
The user agent allows origin servers and proxies to run any remote variant selection algorithm. The origin server may even run algorithms which have not been standardized. If the algorithm has sufficient information to choose a best, neighboring variant, the origin server or proxy MAY return a choice response with this variant. Implies "trans".

Servers SHOULD ignore all negotiate-directives they do not understand. If the Negotiate header allows a choice between multiple remote variant selection algorithms which are all supported by the server, the server SHOULD use some internal precedence heuristics to select the best algorithm.

8.5 TCN

The TCN response header is used by a server to signal that the resource is transparently negotiated.

```
TCN = "TCN" ":" #( response-type
                 | server-side-override-directive
                 | tcn-extension )

response-type = "list" | "choice" | "adhoc"

server-side-override-directive = "re-choose" | "keep"

tcn-extension = token [ "=" ( token | quoted-string ) ]
```

If the resource is not transparently negotiated, a TCN header MUST NOT be included in any response. If the resource is transparently negotiated, a TCN header, which includes the response-type value of the response, MUST be included in every response with a 2xx status code or any 3xx status code, except 304, in which it MAY be included. A TCN header MAY also be included, without a response-type value, in other responses from transparently negotiated resources.

A server-side override directive MUST be included if the origin server performed a server-side override when choosing the response. If the directive is "re-choose", the server MUST include an Alternates header with the variant bound to the negotiable resource in the response, and user agent SHOULD use its internal variant selection algorithm to choose, retrieve, and display the best variant from this list. If the directive is "keep" the user agent SHOULD NOT renegotiate on the response, but display it directly, or act on it directly if it is a redirection response.

Clients SHOULD ignore all tcn-extensions they do not understand.

8.6 Variant-Vary

The Variant-Vary response header can be used in a choice response to record any vary information which applies to the variant data (the entity body combined with some of the entity headers) contained in the response, rather than to the response as a whole.

```
Variant-Vary  = "Variant-Vary" ":" ( "*" | 1#field-name )
```

Use of the Variant-Vary header is discussed in section 10.2.

9 Cache validators

To allow for correct and efficient caching and revalidation of negotiated responses, this specification extends the caching model of HTTP/1.1 [1] in various ways.

This specification does not introduce a `variant-list-max-age' directive which explicitly bounds the freshness lifetime of a cached variant list, like the `max-age' Cache-Control directive bounds the freshness lifetime of a cached response. However, this specification does ensure that a variant list which is sent at a time T by the origin server will never be re-used without revalidation by semantically transparent caches after the time T+M. This M is the maximum of all freshness lifetimes assigned (using max-age directives or Expires headers) by the origin server to

a. the responses from the negotiable resource itself, and

b. the responses from its neighboring variant resources

If no freshness lifetimes are assigned by the origin server, M is the maximum of the freshness lifetimes which were heuristically assigned by all caches which can re-use the variant list.

9.1 Variant list validators

A variant list validator is an opaque value which acts as the cache validator of a variant list bound to a negotiable resource.

```
variant-list-validator = <quoted-string not containing any ";">
```

If two responses contain the same variant list validator, a cache can treat the Alternates headers in these responses as equivalent (though the headers themselves need not be identical).

9.2 Structured entity tags

A structured entity tag consists of a normal entity tag of which the opaque string is extended with a semicolon followed by the text (without the surrounding quotes) of a variant list validator:

normal entity tag	variant list validator	structured entity tag
"etag"	"vlv"	"etag;vlv"
W/"etag"	"vlv"	W/"etag;vlv"

Note that a structured entity tag is itself also an entity tag. The structured nature of the tag allows caching proxies capable of transparent content negotiation to perform some optimizations defined in section 10. When not performing such optimizations, a structured tag SHOULD be treated as a single opaque value, according to the general rules in HTTP/1.1. Examples of structured entity tags are:

```
"xyzzy;1234"  W/"xyzzy;1234"  "gonkxxxx;1234"  "a;b;c;;1234"
```

In the last example, the normal entity tag is "a;b;c;" and the variant list validator is "1234".

If a transparently negotiated response includes an entity tag, it MUST be a structured entity tag. The variant list validator in the structured tag MUST act as a validator for the variant list contained in the Alternates header. The normal entity tag in the structured tag MUST act as a validator of the entity body in the response and of all entity headers except Alternates.

9.3 Assigning entity tags to variants

To allow for correct revalidation of transparently negotiated responses by clients, origin servers SHOULD generate all normal entity tags for the neighboring variant resources of the negotiable resource in such a way that

1. the same tag is never used by two different variants, unless this tag labels exactly the same entity on all occasions,

2. if one normal tag "X" is a prefix of another normal tag "XY", then "Y" must never be a semicolon followed by a variant list validator.

10 Content negotiation responses

If a request on a transparently negotiated resource yields a response with a 2xx status code or any 3xx status code except 304, this response MUST always be either a list response, a choice response, or an adhoc response. These responses MUST always include a TCN header which specifies their type. Transparently negotiated responses with other status codes MAY also include a TCN header.

The conditions under which the different content negotiation responses may be sent are defined in section 12.1 for origin servers and in section 13 for proxies.

After having constructed a list, choice, or adhoc response, a server MAY process any If-No-Match or If-Range headers in the request message and shorten the response to a 304 (Not Modified) or 206 (Partial Content) response, following the rules in the HTTP/1.1 specification [1]. In this case, the entity tag of the shortened response will identify it indirectly as a list, choice, or adhoc response.

10.1 List response

A list response returns the variant list of the negotiable resource, but no variant data. It can be generated when the server does not want to, or is not allowed to, return a particular best variant for the request. If the user agent supports transparent content negotiation, the list response will cause it to select a best variant and retrieve it.

A list response MUST contain (besides the normal headers required by HTTP) a TCN header which specifies the "list" response-type, the Alternates header bound to the negotiable resource, a Vary header and (unless it was a HEAD request) an entity body which allows the user to manually select the best variant.

An example of a list response is

```
HTTP/1.1 300 Multiple Choices
Date: Tue, 11 Jun 1996 20:02:21 GMT
TCN: list
Alternates: {"paper.1" 0.9 {type text/html} {language en}},
            {"paper.2" 0.7 {type text/html} {language fr}},
            {"paper.3" 1.0 {type application/postscript}
                {language en}}
Vary: negotiate, accept, accept-language
ETag: "blah;1234"
Cache-control: max-age=86400
Content-Type: text/html
```

```
Content-Length: 227

<h2>Multiple Choices:</h2>
<ul>
<li><a href=paper.1>HTML, English version</a>
<li><a href=paper.2>HTML, French version</a>
<li><a href=paper.3>Postscript, English version</a>
</ul>
```

Note: A list response can have any status code, but the 300 (Multiple Choices) code is the most appropriate one for HTTP/1.1 clients. Some existing versions of HTTP/1.0 clients are known to silently ignore 300 responses, instead of handling them according to the HTTP/1.0 specification [3]. Servers should therefore be careful in sending 300 responses to non-negotiating HTTP/1.0 user agents, and in making these responses cacheable. The 200 (OK) status code can be used instead.

The Vary header in the response SHOULD ensure correct handling by plain HTTP/1.1 caching proxies. This header can either be

```
Vary: *
```

or a more elaborate header; see section 10.6.1.

Only the origin server may construct list responses. Depending on the status code, a list response is cacheable unless indicated otherwise.

According to the HTTP/1.1 specification [1], a user agent which does not support transparent content negotiation will, when receiving a list response with the 300 status code, display the entity body included in the response. If the response contains a Location header, however, the user agent MAY automatically redirect to this location.

The handling of list responses by clients supporting transparent content negotiation is described in sections 11.1 and 13.

10.2 Choice response

A choice response returns a representation of the best variant for the request, and may also return the variant list of the negotiable resource. It can be generated when the server has sufficient information to be able to choose the best variant on behalf the user agent, but may only be generated if this best variant is a neighboring variant. For request from user agents which do not support transparent content negotiation, a server may always generate a choice response, provided that the variant returned is a neighboring variant. The variant returned in a choice response

need not necessarily be listed in the variant list bound to the negotiable resource.

A choice response merges a normal HTTP response from the chosen variant, a TCN header which specifies the "choice" response-type, and a Content-Location header giving the location of the variant. Depending on the status code, a choice response is cacheable unless indicated otherwise.

Origin servers and proxy caches MUST construct choice responses with the following algorithm (or any other algorithm which gives equal end results for the client).

In this algorithm, `the current Alternates header' refers to the Alternates header containing the variant list which was used to choose the best variant, and `the current variant list validator' refers to the validator of this list. Section 10.4 specifies how these two items can be obtained by a proxy cache.

The algorithm consists of four steps.

1. Construct a HTTP request message on the best variant resource by rewriting the request-URI and Host header (if appropriate) of the received request message on the negotiable resource.

2. Generate a valid HTTP response message, but not one with the 304 (Not Modified) code, for the request message constructed in step 1.

   In a proxy cache, the response can be obtained from cache memory, or by passing the constructed HTTP request towards the origin server. If the request is passed on, the proxy MAY add, modify, or delete If-None-Match and If-Range headers to optimize the transaction with the upstream server.

      Note: the proxy should be careful not to add entity tags of non-neighboring variants to If-* (conditional) headers of the request, as there are no global uniqueness requirements for these tags.

3. Only in origin servers: check for an origin server configuration error. If the HTTP response message generated in step 2 contains a TCN header, then the best variant resource is not a proper end point in the transparent negotiation process, and a 506 (Variant Also Negotiates) error response message SHOULD be generated instead of going to step 4.

4. Add a number of headers to the HTTP response message generated in step 2.

   a. Add a TCN header which specifies the "choice"

response-type.

b. Add a Content-Location header giving the location of the chosen variant. Delete any Content-Location header which was already present.

> Note: According to the HTTP/1.1 specification [1], if the Content-Location header contains a relative URI, this URI is relative to the URI in the Content-Base header, if present, and relative to the request-URI if no Content-Base header is present.

c. If any Vary headers are present in the response message from step 2, add, for every Vary header, a Variant-Vary header with a copy of the contents of this Vary header.

d. Delete any Alternates headers which are present in in the response. Now, the current Alternates header MUST be added if this is required by the Negotiate request header, or if the server returns "re-choose" in the TCN response header. Otherwise, the current Alternates header MAY be added.

> Note: It is usually a good strategy to always add the current Alternates header, unless it is very large compared to the rest of the response.

e. Add a Vary header to ensure correct handling by plain HTTP/1.1 caching proxies. This header can either be

> Vary: *

or a more elaborate header, see section 10.6.

f. To ensure compatibility with HTTP/1.0 caching proxies which do not recognize the Vary header, an Expires header with a date in the past MAY be added. See section 10.7 for more information.

g. If an ETag header is present in the response message from step 2, then extend the entity tag in that header with the current variant list validator, as specified in section 9.2.

> Note: Step g. is required even if the variant list itself is not added in step d.

h. Only in proxy caches: set the Age header of the response to

> max(variant_age , alternates_age)

where variant_age is the age of the variant response

obtained in step 2, calculated according to the rules in the HTTP/1.1 specification [1], and alternates_age is the age of the Alternates header added in step d, calculated according to the rules in section 10.4.

Note that a server can shorten the response produced by the above algorithm to a 304 (Not Modified) response if an If-None-Match header in the original request allows it. If this is the case, an implementation of the above algorithm can avoid the unnecessary internal construction of full response message in step 2, it need only construct the parts which end up in the final 304 response. A proxy cache which implements this optimization can sometimes generate a legal 304 response even if it has not cached the variant data itself.

An example of a choice response is:

```
HTTP/1.1 200 OK
Date: Tue, 11 Jun 1996 20:05:31 GMT
TCN: choice
Content-Type: text/html
Last-Modified: Mon, 10 Jun 1996 10:01:14 GMT
Content-Length: 5327
Cache-control: max-age=604800
Content-Location: paper.1
Alternates: {"paper.1" 0.9 {type text/html} {language en}},
            {"paper.2" 0.7 {type text/html} {language fr}},
            {"paper.3" 1.0 {type application/postscript}
                {language en}}
Etag: "gonkyyyy;1234"
Vary: negotiate, accept, accept-language
Expires: Thu, 01 Jan 1980 00:00:00 GMT

<title>A paper about ....
```

10.3 Adhoc response

An adhoc response can be sent by an origin server as an extreme measure, to achieve compatibility with a non-negotiating or buggy client if this compatibility cannot be achieved by sending a list or choice response. There are very little requirements on the contents of an adhoc response. An adhoc response MUST have a TCN header which specifies the "adhoc" response-type, and a Vary header if the response is cacheable. It MAY contain the Alternates header bound to the negotiable resource.

Any Vary header in the response SHOULD ensure correct handling by plain HTTP/1.1 caching proxies. This header can either be

```
Vary: *
```

or a more elaborate header, see section 10.6.1. Depending on the status code, an adhoc response is cacheable unless indicated otherwise.

As an example of the use of an adhoc response, suppose that the variant resource "redirect-to-blah" yields redirection (302) responses. A choice response with this variant could look as follows:

```
HTTP/1.1 302 Moved Temporarily
Date: Tue, 11 Jun 1996 20:02:28 GMT
TCN: choice
Content-location: redirect-to-blah
Location: http://blah.org/
Content-Type: text/html
Content-Length: 62

This document is available <a href=http://blah.org/>here</a>.
```

Suppose that the server knows that the receiving user agent has a bug, which causes it to crash on responses which contain both a Content-Location and a Location header. The server could then work around this bug by performing a server-side override and sending the following adhoc response instead:

```
HTTP/1.1 302 Moved Temporarily
Date: Tue, 11 Jun 1996 20:02:28 GMT
TCN: adhoc, keep
Location: http://blah.org/
Content-Type: text/html
Content-Length: 62

This document is available <a href=http://blah.org/>here</a>.
```

10.4 Reusing the Alternates header

If a proxy cache has available a negotiated response which is cacheable, fresh, and has ETag and Alternates headers, then it MAY extract the Alternates header and associated variant list validator from the response, and reuse them (without unnecessary delay) to negotiate on behalf of the user agent (section 13) or to construct a choice response (section 10.2). The age of the extracted Alternates header is the age of the response from which it is extracted, calculated according to the rules in the HTTP/1.1 specification [1].

10.5 Extracting a normal response from a choice response

If a proxy receives a choice response, it MAY extract and cache the normal HTTP response contained therein. The normal response can be extracted by taking a copy of the choice response and then deleting any Content-Location, Alternates, and Vary headers, renaming any Variant-Vary headers to Vary headers, and shortening the structured entity tag in any ETag header to a normal entity tag.

This normal response MAY be cached (as a HTTP response to the variant request as constructed in step 1. of section 10.2) and reused to answer future direct requests on the variant resource, according to the rules in the HTTP/1.1 specification [1].

> Note: The caching of extracted responses can decrease the upstream bandwidth usage with up to a factor 2, because two independent HTTP/1.1 cache entries, one associated with the negotiable resource URI and one with the variant URI, are created in the same transaction. Without this optimization, both HTTP/1.1 cache entries can only be created by transmitting the variant data twice.

For security reasons (see section 14.2), an extracted normal response MUST NEVER be cached if belongs to a non-neighboring variant resource. If the choice response claims to contain data for a non-neighboring variant resource, the proxy SHOULD reject the choice response as a probable spoofing attempt.

10.6 Elaborate Vary headers

If a HTTP/1.1 [1] server can generate varying responses for a request on some resource, then the server MUST include a Vary header in these responses if they are cacheable. This Vary header is a signal to HTTP/1.1 caches that something special is going on. It prevents the caches from returning the currently chosen response for every future request on the resource.

Servers engaging in transparent content negotiation will generate varying responses. Therefore, cacheable list, choice, and adhoc responses MUST always include a Vary header.

The most simple Vary header which can be included is

```
Vary: *
```

This header leaves the way in which the response is selected by the server completely unspecified.

A more elaborate Vary header MAY be used to allow for certain optimizations in HTTP/1.1 caches which do not have specific optimizations for transparent content negotiation, but which do cache multiple variant responses for one resource. Such a more

elaborate Vary header lists all request headers which can be used by the server when selecting a response for a request on the resource.

10.6.1 Construction of an elaborate Vary header

Origin servers can construct a more elaborate Vary header in the following way. First, start with the header

```
Vary: negotiate
```

`negotiate' is always included because servers use the information in the Negotiate header when choosing between a list, choice, or adhoc response.

Then, if any of the following attributes is present in any variant description in the Alternates header, add the corresponding header name to the Vary header

attribute	header name to add
type	accept
charset	accept-charset
language	accept-language
features	accept-features

The Vary header constructed in this way specifies the response variation which can be caused by the use of a variant selection algorithm in proxies. If the origin server will in some cases, for example if contacted by a non-negotiating user agent, use a custom negotiation algorithm which takes additional headers into account, these names of these headers SHOULD also be added to the Vary header.

10.6.2 Caching of an elaborate Vary header

A proxy cache cannot construct an elaborate vary header using the method above, because this method requires exact knowledge of any custom algorithms present in the origin server. However, when extracting an Alternates header from a response (section 10.4) caches MAY also extract the Vary header in the response, and reuse it along with the Alternates header. A clean Vary header can however only be extracted if the variant does not vary itself, i.e. if a Variant-Vary header is absent.

10.7 Adding an Expires header to ensure HTTP/1.0 compatibility

To ensure compatibility with HTTP/1.0 caching proxies which do not recognize the Vary header, an Expires header with a date in the past can be added to the response, for example

```
Expires: Thu, 01 Jan 1980 00:00:00 GMT
```

If this is done by an origin server, the server SHOULD usually also include a Cache-Control header for the benefit of HTTP/1.1 caches, for example

```
Cache-Control: max-age=604800
```

which overrides the freshness lifetime of zero seconds specified by the included Expires header.

> Note: This specification only claims downwards compatibility with the HTTP/1.0 proxy caches which implement the HTTP/1.0 specification [3]. Some legacy proxy caches which return the HTTP/1.0 protocol version number do not honor the HTTP/1.0 Expires header as specified in [3]. Methods for achieving compatibility with such proxy caches are beyond the scope of this specification.

10.8 Negotiation on content encoding

Negotiation on the content encoding of a response is orthogonal to transparent content negotiation. The rules for when a content encoding may be applied are the same as in HTTP/1.1: servers MAY content-encode responses that are the result of transparent content negotiation whenever an Accept-Encoding header in the request allows it. When negotiating on the content encoding of a cacheable response, servers MUST add the accept-encoding header name to the Vary header of the response, or add `Vary: *'.

Servers SHOULD always be able to provide unencoded versions of every transparently negotiated response. This means in particular that every variant in the variant list SHOULD at least be available in an unencoded form.

Like HTTP/1.1, this specification allows proxies to encode or decode relayed or cached responses on the fly, unless explicitly forbidden by a Cache-Control directive. The encoded or decoded response still contains the same variant as far as transparent content negotiation is concerned. Note that HTTP/1.1 requires proxies to add a Warning header if the encoding of a response is changed.

11 User agent support for transparent negotiation

This section specifies the requirements a user agent needs to satisfy in order to support transparent negotiation. If the user agent contains an internal cache, this cache MUST conform to the

rules for proxy caches in section 13.

11.1 Handling of responses

If a list response is received when a resource is accessed, the user agent MUST be able to automatically choose, retrieve, and display the best variant, or display an error message if none of the variants are acceptable.

If a choice response is received when a resource is accessed, the usual action is to automatically display the enclosed entity. However, if a remote variant selection algorithm which was enabled could have made a choice different from the choice the local algorithm would make, the user agent MAY apply its local algorithm to any variant list in the response, and automatically retrieve and display another variant if the local algorithm makes an other choice.

When receiving a choice response, a user agent SHOULD check if variant resource is a neighboring variant resource of the negotiable resource. If this is not the case, the user agent SHOULD reject the choice response as a probable spoofing attempt and display an error message, for example by internally replacing the choice response with a 502 (bad gateway) response.

11.2 Presentation of a transparently negotiated resource

If the user agent is displaying a variant which is not an embedded or inlined object and which is the result of transparent content negotiation, the following requirements apply.

1. The user agent SHOULD allow the user to review a list of all variants bound to the negotiable resource, and to manually retrieve another variant if desired. There are two general ways of providing such a list. First, the information in the Alternates header of the negotiable resource could be used to make an annotated menu of variants. Second, the entity included in a list response of the negotiable resource could be displayed. Note that a list response can be obtained by doing a GET request which only has the "trans" directive in the Negotiate header.

2. The user agent SHOULD make available though its user interface some indication that the resource being displayed is a negotiated resource instead of a plain resource. It SHOULD also allow the user to examine the variant list included in the Alternates header. Such a notification and review mechanism is needed because of privacy considerations, see section 14.1.

3. If the user agent shows the URI of the displayed information to the user, it SHOULD be the negotiable resource URI, not the variant URI that is shown. This encourages third parties, who want to refer to the displayed information in their own documents, to make a hyperlink to the negotiable resource as a whole, rather than to the variant resource which happens to be shown. Such correct linking is vital for the interoperability of content across sites. The user agent SHOULD however also provide a means for reviewing the URI of the particular variant which is currently being displayed.

4. Similarly, if the user agent stores a reference to the displayed information for future use, for example in a hotlist, it SHOULD store the negotiable resource URI, not the variant URI.

It is encouraged, but not required, that some of the above functionality is also made available for inlined or embedded objects, and when a variant which was selected manually is being displayed.

12 Origin server support for transparent negotiation

12.1 Requirements

To implement transparent negotiation on a resource, the origin server MUST be able to send a list response when getting a GET request on the resource. It SHOULD also be able to send appropriate list responses for HEAD requests. When getting a request on a transparently negotiable resource, the origin server MUST NEVER return a response with a 2xx status code or any 3xx status code, except 304, which is not a list, choice, or adhoc response.

If the request includes a Negotiate header with a "vlist" or "trans" directive, but without any directive which allows the server to select a best variant, a list response MUST ALWAYS be sent, except when the server is performing a server-side override for bug compatibility. If the request includes a Negotiate header with a "vlist" or "guess-small" directive, an Alternates header with the variant list bound to the negotiable resource MUST ALWAYS be sent in any list, choice, or adhoc response, except when the server is performing a server-side override for bug compatibility.

If the Negotiate header allows it, the origin server MAY run a remote variant selection algorithm. If the algorithm has sufficient information to choose a best variant, and if the best variant is a neighboring variant, the origin server MAY return a choice response with this variant.

When getting a request on a transparently negotiable resource from a user agent which does not support transparent content negotiation, the origin server MAY use a custom algorithm to select between sending a list, choice, or adhoc response.

The following table summarizes the rules above.

Req on trans neg resource?	Usr agnt capable of TCN?	server-side override?	Response may be: list	choice	adhoc	normal	error
Yes	Yes	No	always	smt(*)	never	never	always
Yes	Yes	Yes	always	always	always	never	always
Yes	No	-	always	always	always	never	always
No	-	-	never	never	never	always	always

(*) sometimes, when allowed by the Negotiate request header

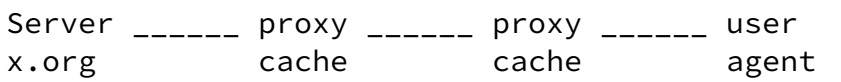
Negotiability is a binary property: a resource is either transparently negotiated, or it is not. Origin servers SHOULD NOT vary the negotiability of a resource, or the variant list bound to that resource, based on the request headers which are received. The variant list and the property of being negotiated MAY however change through time. The Cache-Control header can be used to control the propagation of such time-dependent changes through caches.

It is the responsibility of the author of the negotiable resource to ensure that all resources in the variant list serve the intended content, and that the variant resources do not engage in transparent content negotiation themselves.

12.2 Negotiation on transactions other than GET and HEAD

If a resource is transparently negotiable, this only has an impact on the GET and HEAD transactions on the resource. It is not possible (under this specification) to do transparent content negotiation on the direct result of a POST request.

However, a POST request can return an unnegotiated 303 (See Other) response which causes the user agent to do a GET request on a second resource. This second resource could then use transparent content negotiation to return an appropriate final response. The figure below illustrates this.



See the HTTP/1.1 specification [1] for details on the 303 (See Other) status code. Note that this status code is not understood by some HTTP/1.0 clients.

13 Proxy support for transparent negotiation

Transparent content negotiation is an extension on top of HTTP/1.x. It is designed to work through any proxy which only implements the HTTP/1.1 specification [1]. If Expires headers are added as discussed in section 10.7, negotiation will also work though proxies which implement HTTP/1.0 [3]. Thus, every HTTP/1.0 or HTTP/1.1 proxy provides support for transparent content negotiation. However, if it is to be claimed that a HTTP/1.x proxy offers transparent content negotiation services, at least one of the specific optimizations below MUST be implemented.

An HTTP/1.x proxy MUST ONLY optimize (change) the HTTP traffic flowing through it in ways which are explicitly allowed by the specification(s) it conforms to. A proxy which supports transparent content negotiation on top of HTTP/1.x MAY perform the optimizations allowed for by HTTP/1.x. In addition, it MAY perform three additional optimizations, defined below, on the HTTP traffic for transparently negotiated resources and their neighboring variant resources.

First, when getting a request on a transparently negotiable resource from a user agent which supports transparent content negotiation, the proxy MAY return any cached, fresh list response from that resource, even if the selecting request headers, as specified by the Vary header, do not match.

Second, when allowed by the user agent and origin server, a proxy MAY reuse an Alternates header taken from a previous response (section 10.4) to run a remote variant selection algorithm. If the algorithm has sufficient information to choose a best variant, and if the best variant is a neighboring variant, the proxy MAY return a choice response with this variant.

Third, if a proxy receives a choice response, it MAY extract and cache the normal response embedded therein, as described in section 10.5.

14 Security and privacy considerations

14.1 Accept- headers revealing information of a private nature

Accept- headers, in particular Accept-Language headers, may reveal information which the user would rather keep private unless it will directly improve the quality of service. For example, a user may not want to send language preferences to sites which do not offer multi-lingual content. The transparent content negotiation mechanism allows user agents to omit sending of the Accept-Language header by default, without adversely affecting the outcome of the negotiation process if transparently negotiated multi-lingual content is accessed.

However, even if Accept- headers are never sent, the automatic selection and retrieval of a variant by a user agent will reveal a preference for this variant to the server. A malicious service author could provide a page with `fake' negotiability on (ethnicity-correlated) languages, with all variants actually being the same English document, as a means of obtaining privacy-sensitive information. Such a plot would however be visible to an alert victim if the list of available variants and their properties is reviewed.

Some additional privacy considerations connected to Accept- headers are discussed in [1].

14.2 Spoofing of responses from variant resources

The caching optimization in section 10.5 gives the implementer of a negotiable resource control over the responses cached for all neighboring variant resources. This is a security problem if a neighboring variant resource belongs to another author. To provide security in this case, the HTTP server will have to filter the Content-Location headers in the choice responses generated by the negotiable resource implementation.

14.3 Security holes revealed by negotiation

Malicious servers could use transparent content negotiation as a means of obtaining information about security holes which may be present in user agents. This is a risk in particular for negotiation on the availability of scripting languages and libraries.

15 Acknowledgments

Work on HTTP content negotiation has been done since at least 1993. The authors are unable to trace the origin of many of the ideas incorporated in this document. This specification builds on an earlier incomplete specification of content negotiation recorded in [2]. Many members of the HTTP working group have contributed to the negotiation model in this specification. The authors wish to thank the individuals who have commented on earlier versions of this document, including Brian Behlendorf, Daniel DuBois, Martin J. Duerst, Roy T. Fielding, Jim Gettys, Yaron Goland, Dirk van Gulik, Ted Hardie, Graham Klyne, Scott Lawrence, Larry Masinter, Jeffrey Mogul, Henrik Frystyk Nielsen, Frederick G.M. Roeber, Paul Sutton, and Klaus Weide and Mark Wood.

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18 Appendix: Example of a local variant selection algorithm

A negotiating user agent will choose the best variant from a variant list with a local variant selection algorithm. This appendix contains an example of such an algorithm.

The inputs of the algorithm are a variant list from an Alternates header, and an agent-side configuration database, which contains

- the feature set of the current request,
- a collection of quality values assigned to media types, languages, and charsets for the current request, following the model of the corresponding HTTP/1.1 [1] Accept- headers,
- a table which lists `forbidden' combinations of media types and charsets, i.e. combinations which cannot be displayed because of some internal user agent limitation.

The output of the algorithm is either the best variant, or the conclusion that none of the variants are acceptable.

18.1 Computing overall quality values

As a first step in the local variant selection algorithm, the overall qualities associated with all variant descriptions in the list are computed.

The overall quality Q of a variant description is the value

```
   Q = round5( qs * qt * qc * ql * qf * qa )
```

where rounds5 is a function which rounds a floating point value to 5 decimal places after the point. It is assumed that the user agent can run on multiple platforms: the rounding function makes the algorithm independent of the exact characteristics of the underlying floating point hardware.

The factors qs, qt, qc, ql, qf, and qa are determined as follows.

qs Is the source quality factor in the variant description.

qt The media type quality factor is 1 if there is no type attribute in the variant description. Otherwise, it is the quality value assigned to this type by the configuration database. If the database does not assign a value, then the factor is 0.

qc The charset quality factor is 1 if there is no charset attribute in the variant description. Otherwise, it is the quality value assigned to this charset by the configuration database. If the database does not assign a value, then the factor is 0.

ql The language quality factor is 1 if there is no language attribute in the variant description. Otherwise, it is the highest quality value the configuration database assigns to any of the languages listed in the language attribute. If the database does not assign a value to any of the languages listed, then the factor is 0.

qf The features quality factor is 1 if there is no features attribute in the variant description. Otherwise, it is the quality degradation factor computed for the features attribute using the feature set of the current request.

qa The quality adjustment factor is 0 if the variant description lists a media type - charset combination which is `forbidden' by the table, and 1 otherwise.

As an example, if a variant list contains the variant description

```
  {"paper.2" 0.7 {type text/html} {language fr}}
```

and if the configuration database contains the quality value assignments

```
  types:     text/html;q=1.0, type application/postscript;q=0.8
  languages: en;q=1.0, fr;q=0.5
```

then the local variant selection algorithm will compute the overall quality for the variant description as follows:

```
  {"paper.2" 0.7 {type text/html} {language fr}}
              |           |                 |
              |           |                 |
              V           V                 V
    round5 ( 0.7   *     1.0        *      0.5 ) = 0.35000
```

With same configuration database, the variant list

```
  {"paper.1" 0.9 {type text/html} {language en}},
  {"paper.2" 0.7 {type text/html} {language fr}},
  {"paper.3" 1.0 {type application/postscript} {language en}}
```

would yield the following computations:

```
    round5 ( qs  * qt  * qc  * ql  * qf  * qa ) = Q
             ---   ---   ---   ---   ---   ---
   paper.1:  0.9 * 1.0 * 1.0 * 1.0 * 1.0 * 1.0  = 0.90000
   paper.1:  0.7 * 1.0 * 1.0 * 0.5 * 1.0 * 1.0  = 0.35000
   paper.3:  1.0 * 0.8 * 1.0 * 1.0 * 1.0 * 1.0  = 0.80000
```

18.2 Determining the result

Using all computed overall quality values, the end result of the local variant selection algorithm is determined as follows.

If all overall quality values are 0, then the best variant is the fallback variant, if there is one in the list, else the result is the conclusion that none of the variants are acceptable.

If at least one overall quality value is greater than 0, then the best variant is the variant which has the description with the highest overall quality value, or, if there are multiple variant descriptions which share the highest overall quality value, the variant of the first variant description in the list which has this highest overall quality value.

18.3 Ranking dimensions

Consider the following variant list:

```
  {"paper.greek"   1.0 {language el} {charset ISO-8859-7}},
  {"paper.english" 1.0 {language en} {charset ISO-8859-1}}
```

It could be the case that the user prefers the language "el" over "en", while the user agent can render "ISO-8859-1" better than

"ISO-8859-7". The result is that in the language dimension, the first variant is best, while the second variant is best in the charset dimension. In this situation, it would be preferable to choose the first variant as the best variant: the user settings in the language dimension should take precedence over the hard-coded values in the charset dimension.

To express this ranking between dimensions, the user agent configuration database should have a higher spread in the quality values for the language dimension than for the charset dimension. For example, with

```
languages: el;q=1.0, en-gb;q=0.7, en;q=0.6, da;q=0, ...

charsets:  ISO-8859-1;q=1.0, ISO-8859-7;q=0.95,
           ISO-8859-5;q=0.97, unicode-1-1;q=0, ...
```

the first variant will have an overall quality of 0.95000, while the second variant will have an overall quality 0.70000. This makes the first variant the best variant.

19 Appendix: feature negotiation examples

This appendix contains examples of the use of feature tags in variant descriptions. The tag names used here are examples only, they do not in general reflect the tag naming scheme proposed in [4].

19.1 Use of feature tags

Feature tags can be used in variant lists to express the quality degradation associated with the presence or absence of certain features. One example is

```
{"index.html.plain" 0.7 },
{"index.html"       1.0 {features tables frames}}
```

Here, the "{features tables frames}" part expresses that index.html uses the features tagged as tables and frames. If these features are absent, the overall quality of index.html degrades to 0. Another example is

```
{"home.graphics" 1.0 {features !textonly}},
{"home.textonly" 0.7 }
```

where the "{features !textonly}" part expresses that home.graphics requires the absence of the textonly feature. If the feature is present, the overall quality of home.graphics degrades to 0.

The absence of a feature need not always degrade the overall quality

to 0. In the example

```
{"x.html.1" 1.0 {features fonts;-0.7}}
```

the absence of the fonts feature degrades the quality with a factor of 0.7. Finally, in the example

```
 {"y.html" 1.0 {features [blebber wolx] }}
```

The "[blebber wolx]" expresses that y.html requires the presence of the blebber feature or the wolx feature. This construct can be used in a number of cases:

1. blebber and wolx actually tag the same feature, but they were registered by different people, and some user agents say they support blebber while others say they support wolx.

2. blebber and wolx are HTML tags of different vendors which implement the same functionality, and which are used together in y.html without interference.

3. blebber and wolx are HTML tags of different vendors which implement the same functionality, and y.html uses the tags in a conditional HTML construct.

4. blebber is a complicated HTML tag with only a sketchy definition, implemented by one user agent vendor, and wolx indicates implementation of a well-defined subset of the blebber tag by some other vendor(s). y.html uses only this well-defined subset.

19.2 Use of numeric feature tags

As an example of negotiation in a numeric area, the following variant list describes four variants with title graphics designed for increasing screen widths:

```
{"home.pda"    1.0 {features screenwidth=[-199] }},
{"home.narrow" 1.0 {features screenwidth=[200-599] }},
{"home.normal" 1.0 {features screenwidth=[600-999] }},
{"home.wide"   1.0 {features screenwidth=[1000-] }},
{"home.normal"}
```

The last element of the list specifies a safe default for user agents which do not implement screen width negotiation. Such user agents will reject the first four variants as unusable, as they seem to rely on a feature which they do not understand.

19.3 Feature tag design

When designing a new feature tag, it is important to take into account that existing user agents, which do not recognize the new tag will treat the feature as absent. In general, a new feature tag needs to be designed in such a way that absence of the tag is the default case which reflects current practice. If this design principle is ignored, the resulting feature tag will generally be unusable.

As an example, one could try to support negotiation between monochrome and color content by introducing a `color' feature tag, the presence of which would indicate the capability to display color graphics. However, if this new tag is used in a variant list, for example

```
{"rainbow.gif"      1.0 {features color} }
{"rainbow.mono.gif" 0.6 {features !color}}
```

then existing user agents, which would not recognize the color tag, would all display the monochrome rainbow. The color tag is therefore unusable in situations where optimal results for existing user agents are desired. To provide for negotiation in this area, one must introduce a `monochrome' feature tag; its presence indicates that the user agent can only render (or the user prefers to view) monochrome graphics.

20 Appendix: origin server implementation considerations

20.1 Implementation with a CGI script

Transparent content negotiation has been designed to allow a broad range of implementation options at the origin server side. A very minimal implementation can be done using the CGI interface. The CGI script below is an example.

```
#!/bin/sh

cat - <<'blex'
TCN: list
Alternates: {"stats.tables.html" 1.0 {type text/html} {features
tables}}, {"stats.html" 0.8 {type text/html}}, {"stats.ps" 0.95
{type application/postscript}}
Vary: *
Content-Type: text/html

<title>Multiple Choices for Web Statistics</title>
<h2>Multiple Choices for Web Statistics:</h2>
<ul>
<li><a href=stats.tables.html>Version with HTML tables</a>
<p>
```

```
   <li><a href=stats.html>Version without HTML tables</a>
   <p>
   <li><a href=stats.ps>Postscript version</a>
   </ul>
   blex
```

The Alternates header in the above script must be read as a single line. The script always generates a list response with the 200 (OK) code, which ensures compatibility with non-negotiating HTTP/1.0 agents.

20.2 Direct support by HTTP servers

Sophisticated HTTP servers could make a transparent negotiation module available to content authors. Such a module could incorporate a remote variant selection algorithm and an implementation of the algorithm for generating choice responses (section 10.2). The definition of interfaces to such modules is beyond the scope of this specification.

20.3 Web publishing tools

Web publishing tools could automatically generate several variants of a document (for example the original TeX version, a HTML version with tables, a HTML version without tables, and a Postscript version), together with an appropriate variant list in the interface format of a HTTP server transparent negotiation module. This would allow documents to be published as transparently negotiable resources.

21 Appendix: Example of choice response construction

The following is an example of the construction of a choice response by a proxy cache which supports HTTP/1.1 and transparent content negotiation. The use of the HTTP/1.1 conditional request mechanisms is also shown.

Assume that a user agent has cached a variant list with the validator "1234" for the negotiable resource http://x.org/paper. Also assume that it has cached responses from two neighboring variants, with the entity tags "gonkyyyy" and W/"a;b". Assume that all three user agent cache entries are stale: they would need to be revalidated before the user agent can use them. If http://x.org/paper accessed in this situation, the user agent could send the following request to its proxy cache:

```
  GET /paper HTTP/1.1
  Host: x.org
```

```
  User-Agent: WuxtaWeb/2.4
  Negotiate: 1.0
  Accept: text/html, application/postscript;q=0.4, */*
  Accept-Language: en
  If-None-Match: "gonkyyyy;1234", W/"a;b;1234"
```

Assume that the proxy cache has cached the same three items as the user agent, but that it has revalidated the variant list 8000 seconds ago, so that the list is still fresh for the proxy. This means that the proxy can run a remote variant selection algorithm on the list and the incoming request.

Assume that the remote algorithm is able to choose paper.html.en as the best variant. The proxy can now construct a choice response, using the algorithm in section 10.2. In steps 1 and 2 of the algorithm, the proxy can construct the following conditional request on the best variant, and send it to the origin server:

```
  GET /paper.html.en HTTP/1.1
  Host: x.org
  User-Agent: WuxtaWeb/2.4
  Negotiate: 1.0
  Accept: text/html, application/postscript;q=0.4, */*
  Accept-Language: en
  If-None-Match: "gonkyyyy", W/"a;b"
  Via: 1.1 fred
```

On receipt of the response

```
  HTTP/1.1 304 Not Modified
  Date: Tue, 11 Jun 1996 20:05:31 GMT
  Etag: "gonkyyyy"
```

from the origin server, the proxy can use its freshly revalidated paper.html.en cache entry to expand the response to a non-304 response:

```
  HTTP/1.1 200 OK
  Date: Tue, 11 Jun 1996 20:05:31 GMT
  Content-Type: text/html
  Last-Modified: Mon, 10 Jun 1996 10:01:14 GMT
  Content-Length: 5327
  Cache-control: max-age=604800
  Etag: "gonkyyyy"
  Via: 1.1 fred
  Age: 0

  <title>A paper about ....
```

Using this 200 response, the proxy can construct a choice response in step 4 of the algorithm:

```
  HTTP/1.1 200 OK
  Date: Tue, 11 Jun 1996 20:05:31 GMT
  TCN: choice
  Content-Type: text/html
  Last-Modified: Mon, 10 Jun 1996 10:01:14 GMT
  Content-Length: 5327
  Cache-control: max-age=604800
  Content-Location: paper.html.en
  Alternates: {"paper.html.en" 0.9 {type text/html} {language en}},
              {"paper.html.fr" 0.7 {type text/html} {language fr}},
              {"paper.ps.en"   1.0 {type application/postscript}
                  {language en}}
  Etag: "gonkyyyy;1234"
  Vary: negotiate, accept, accept-language
  Expires: Thu, 01 Jan 1980 00:00:00 GMT
  Via: 1.1 fred
  Age: 8000

  <title>A paper about ....
```

The choice response can subsequently be shortened to a 304 response, because of the If-None-Match header in the original request from the user agent. Thus, the proxy can finally return

```
  HTTP/1.1 304 Not Modified
  Date: Tue, 11 Jun 1996 20:05:31 GMT
  Etag: "gonkyyyy;1234"
  Content-Location: paper.html.en
  Vary: negotiate, accept, accept-language
  Expires: Thu, 01 Jan 1980 00:00:00 GMT
  Via: 1.1 fred
  Age: 8000
```

to the user agent.