The MIME Application/Vnd.pwg-multiplexed Content-Type

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IESG Note

   The IESG believes use of this media type is only appropriate in
   situations where the producer is fully aware of the capabilities and
   limitations of the consumer. In particular, this mechanism is very
   dependent on the producer knowing when the consumer will need a
   particular component of a multipart object. But consumers
   potentially work in many different ways and different consumers may
   need different things at different times. This mechanism provides no
   means for a producer to determine the needs of a particular consumer
   and how they are to be accommodated.

   Alternative mechanisms, such as a protocol based on BEEP which is
   capable of bidirectional communication between the producer and
   consumer, should be considered when the capabilities of the consumer
   are not known by the producer.

Abstract

   The Application/Vnd.pwg-multiplexed content-type, like the
   Multipart/Related content-type, provides a mechanism for representing
   objects that consist of multiple components. An
   Application/Vnd.pwg-multiplexed entity contains a sequence of chunks.
   Each chunk contains a MIME message or a part of a MIME message. Each
   MIME message represents a component of the compound object, just as a
   body part of a Multipart/Related entity represents a component. With
   a Multipart/Related entity, a body part and its reference in some
   other body part may be separated by many octets. With an
   Application/Vnd.pwg-multiplexed entity, a message and its reference
   in some other message can be made quite close by chunking the message
   containing the reference. For example, if a long message contains

references to images and the producer does not know of the need for
each image until it generates the reference, then
Application/Vnd.pwg-multiplexed allows the consumer to process the
reference to the image and the image before it consumes the entire
long message. This ability is important in printing and scanning
applications. This document defines the Application/Vnd.pwg-
multiplexed content-type. It also provides examples of its use.

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1. Introduction

   The simple MIME content-types, such as "text/plain" provide a
   mechanism for representing a simple object, such as a text document.
   The Multipart/Related [RFC2387] content-type provides a mechanism for
   representing a compound object, such as a text document with two gif
   images.

   A compound object consists of multiple components. One such
   component is the root component, which contains references to other
   components of the compound object. These components may, in turn,
   contain references to other components of the compound object. For
   example, a compound object could consist of a root html text
   component and two gif image components -- each referenced by the root
   component.

A compound object and a component are both abstractions. For
transmission over the wire or writing to storage, each needs a
representation. A "Multipart/Related entity" is one possible
representation of a compound object, and a "body part" is one
possible representation of a component.

However, the Multipart/Related content-type is not a good solution
for applications that require each component to be close to its
corresponding reference in the root component. This document defines
a new MIME content-type Application/Vnd.pwg-multiplexed that provides
a better solution for some applications. The Application/Vnd.pwg-
multiplexed content-type, like the Multipart/Related content-type,
provides a common mechanism for representing a compound object. A
Multipart/Related entity consists of a sequence of body parts
separated by boundary strings. Each body part represents a component
of the compound object. An Application/Vnd.pwg-multiplexed entity
consists of a sequence of chunks, each of whose length is specified
in the chunk header. Each chunk contains a message or a part of a
message. Each message represents a component of the compound object.
Chunks from different messages can be interleaved. HTTP is the
typical transport for an Application/Vnd.pwg-multiplexed entity over
the wire. An Application/Vnd.pwg-multiplexed entity could be stored
in a Microsoft HTML (message/rfc822) file whose suffix is .mht.

The following paragraphs contain three examples of applications. For
each application, there is a discussion of its solution with the
Application/Vnd.pwg-multiplexed content-type, the Multipart/Related
content-type and BEEP [RFC3080].

Example 1: a printing application. A Producer creates a print stream
that consists of a very long series of page descriptions, each of
which references one or more images. The root component is the long
series of page descriptions. An image may be referenced from
multiple pages descriptions, and there is a mechanism to indicate
when there are no additional references to an image (i.e., the image
is out of scope). The Producer does not know what images to include
with a page until it generates that page. The Consumer is presumed
to have enough storage to hold all in-scope images and enough of the
root component to process at least one page. The Producer doesn't
need any knowledge of the Consumer's storage capabilities in order to
create an entity that the Consumer can successfully process.
However, the Producer needs to be prudent about the number of images
that are in-scope at any time. Of course, a malicious Producer may
try to exceed the storage capabilities of the Consumer, and the
Consumer must guard against such entities (see section 6). Here are
ways to represent this compound object.

With the Application/Vnd.pwg-multiplexed content-type, each image
is a message and the root component is a message. The Producer
breaks the root component message into chunks with each image
message occurring shortly before its first reference. When the
Consumer encounters a reference, it can assume that it has already
received the referenced image in an earlier chunk.

With the Multipart/Related content-type, each image must either
precede or follow the root component.

   If images follow the root component, the Consumer must read all
   remaining pages of the root component before it can print the
   first page that references such images. The Consumer must wait
   to print such a page until it has received the entire root
   component, and the Consumer may not have the space to hold the
   remaining pages.

   If images precede the root component, the Producer must
   determine and send all such images before it sends the root
   component. The Consumer must, in the best case, wait some
   additional time before it receives the first page of the root
   component. In the worse case, the Consumer may not have enough
   storage for all the images.

   The Multipart/Related solution is not a good solution because
   of the wait time and because, in some cases, the Consumer may
   not have sufficient storage for all of the images.

With BEEP, the images and root component can be sent in separate
channels. The Producer can push each image when it encounters the
first reference or the Consumer can request it when it encounters
the first reference. The over-the-wire stream of octets is
similar to an Application/Vnd.pwg-multiplexed entity. However,
there is a substantial difference in behavior for a printing
application. With the Application/Vnd.pwg-multiplexed content-
type, the Producer puts each image message before its first
reference so that when the Consumer encounters a reference, the
image is guaranteed to be present on the printer. With BEEP, if
the Consumer pulls the image, the Consumer has to wait while the
image comes over the network. If the Producer pushes the image,
BEEP may put the image message after its first reference and the
Consumer may still have to wait for the image. A high-speed
printer should not have to risk waiting for images; otherwise it
cannot run at full speed.

Example 2: a scanning (fax-like) application. The Producer is a
scanner, which scans pages and sends them along with a vnd.pwg-
xhtml-print+xml root component that contains references to each page

image. Each page is referenced exactly once in the root-component.
The Consumer is a printer that consumes vnd.pwg-xhtml-print+xml
entities and their attachments. That is, the Consumer is not limited
to print jobs that come from scanners. A Producer and Consumer are
each presumed to have enough storage to hold a few page images and
most if not all of the root component. The Producer doesn't need any
additional knowledge of the Consumer's storage capabilities in order
to create an entity that the Consumer can successfully process. Of
course, a malicious Producer may try to exceed the storage
capabilities of the Consumer and the Consumer must guard against such
entities (see section 6). Here are ways to represent this compound
object.

   With the Application/Vnd.pwg-multiplexed content-type, each page
   image is a message and the root component is a message. The
   Producer breaks the root component message into chunks with each
   image message just before or just after its reference.

   With the Multipart/Related content-type, the images cannot precede
   the root component because the Consumer might not have enough
   space to store them until the root component arrived. In this
   case, the printer could fail to print the job correctly and the
   Producer might not know. Therefore the images must follow the
   root component, and the Producer must scan all pages before it can
   send the first page. At the very least, this solution delays the
   printing of the pages until all have been scanned. In the worst
   case, the Producer does not have sufficient memory to buffer the
   images, and the job fails.

   With BEEP, the issues are the same as in the previous example,
   except that speed is not as important in this case. So BEEP is a
   viable alternative for this example.

Example 3: a printing application. A Producer creates a print stream
that consists of a series of pages, each of which references zero or
more images. Each image is referenced exactly once. The Producer
does not know what images to include with a page until it generates
that page, and the Producer doesn't know the layout details; the
Consumer handles layout. The Producer has enough storage to send the
root component and all images. However, it may not have enough
storage to hold the entire root component or all octets of any of the
images. The Consumer is presumed to have enough storage to render
the root component and to render each image. It may not have enough
storage to hold the entire root component or all octets of any of the
images. The Producer doesn't determine the Consumer's storage
capabilities. Rather it arranges the components so that the Consumer
is mostly likely to succeed. Of course, a malicious Producer may try

to exceed the storage capabilities of the Consumer, and the Consumer
must guard against such entities (see section 6). Here are ways to
represent this compound object.

With the Application/Vnd.pwg-multiplexed content-type, each image
is a message and the root component is a message. The Producer
breaks the root component message into chunks with each image
message just after its reference. The references appear first so
that the Consumer knows the location of each image before it
processes the image. This strategy minimizes storage needs for
Producer and Consumer and provides a good strategy in case of
failure. Here are the cases to consider.

a) When the document consists of vertically aligned blocks where
   each block contains either lines of text or a single image, the
   sequence of chunks is the same as the sequence of printable
   blocks, thus minimizing Consumer buffering needs.

b) When a block can contain N side-by-side images, the Consumer
   must buffer N-1 images unless the Producer interleaves the
   images. If the Producer doesn't interleave the images, and the
   Consumer runs out of storage before it has received N-1,
   images, it can print what it has and print the remaining images
   below; not what the Producer intended, but better than nothing.
   If the Producer interleaves images, and the Consumer runs out
   of storage before it has received the bands of N images, the
   Consumer would print portions of images interleaved with
   portions of other images. So, a Producer should not interleave
   images.

c) When a block contains text and image side-by-side (i.e., run-
   around text), there are additional buffering requirements.
   When the Consumer processes the text that follows the
   reference, it will place some of it next to the image (run-
   around text) and will place the remaining text after the image.
   The Producer doesn't know where the run-around ends, and thus
   doesn't know where to end the text chunk and start the image
   chunk. If the Producer ends the text too soon, then the
   Consumer either has to process the entire image (if it has
   enough storage) in order to get the remaining run-around text,
   or it ends the run-around text prematurely. If the Producer
   ends the text too late, then the Consumer may have to store too
   much text and possibly put the image later than the Producer
   requested. Because text data requires significantly less
   storage than image data, a good strategy for Producer is to err
   on the side of sending too much rather than too little text
   before the image data.

   d) When a block contains text and multiple side-by-side images,
      the problem becomes a combination of items b) and c) above.

   The Application/Vnd.pwg-multiplexed content-type can be made to
   work in this example, but a Consumer must have failure strategies
   and the result may not be quite what the producer intended. With
   the Multipart/Related content-type, the images cannot precede the
   root component because the Consumer might not have enough space to
   store them until the root component arrived. Also, the images
   cannot follow the root component because the Consumer might not
   have enough storage for the root component before the first image
   arrives. So the Multipart/Related content-type is not an
   acceptable solution for this example.

   With BEEP, the Producer can send the root component on channel 1
   and the Consumer can request images on even numbered channels when
   it encounters a reference. This solution allows more flexibility
   than the Application/Vnd.pwg-multiplexed content-type. If there
   are side-by-side images and/or run-around text, the Consumer can
   request bands of each image or run-around text over separate
   channels.

In all of these examples, the Application/Vnd.pwg-multiplexed
content-type provides a much better solution than Multipart/Related.
However, it is evenly matched with BEEP. For applications where
speed is important and ordering of the chunks is important in order
to avoid printing delays, the Application/Vnd.pwg-multiplexed
content-type is best. For applications, where the Consumer needs
more control over the ordering of received octets, BEEP is best.

2. Terminology

This document uses some of the MIME terms that are defined in
[RFC2045]. The following are the terms used in this document:

   Entity: the headers and the content. In this document, the term
   "entity" describes all the octets that represent a compound
   object.

   Message: an entity as in [RFC2045]. In this document, the term
   "message" describes all octets that represent one component of a
   compound object. That is, it has MIME headers and content.

   Body Part: an entity inside a multipart. That is, a body part is
   the headers and content (i.e., octets) between the multipart
   boundary strings not including the CRLF at the beginning and end.
   This document never uses "entity" to mean "body part".

Headers: the initial lines of an entity, message or body part. An
empty line (i.e., two adjacent CRLFs) terminates the headers.
Sometimes the term "MIME header" is used instead of just "header".

Content: the part of an entity, message or body part that follows
the headers (i.e., follows the two adjacent CRLFs). The content
of a body part ends at the octet preceding the CRLF before the
multipart boundary string. The content of a message ends at the
octets specified by the length field in the Chunk Header.

This document uses the following additional terms.

Chunk: a chunk of data, consisting of a chunk header, a chunk
payload and a CRLF.

Chunk Header: the first line of a chunk. The line consists of the
"CHK" keyword, the message number, the length and the continuation
indicator, each separated by a single space character (ASCII 32).
A CRLF terminates the line. Each message in an
Application/Vnd.pwg-multiplexed entity has a message number that
normally differs from the message numbers of all other messages in
the Application/Vnd.pwg-multiplexed entity. The message number 0
is reserved for final Chunk Header in the Application/Vnd.pwg-
multiplexed entity.

Chunk Payload: the octets between the Chunk Header and the Chunk
Header of the next chunk. The length field in the header's length
field specifies the number of octets in the Chunk Payload. The
Chunk Payload is either a complete message or a part of a message.
The continuation field in the header specifies whether the chunk
is the last chunk of the message.

CRLF: the sequence of octets corresponding to the two US-ASCII
characters CR (decimal value 13) and LF (decimal value 10) which,
taken together, in this order, denote a line break. A CRLF
terminates each chunk in order to provide visual separation from
the next chunk header.

Consumer: the software that receives and processes a MIME entity,
e.g., software in a printer or software that reads a file.

Producer: the software that creates and sends a MIME entity, e.g.,
software in a scanner or software that writes a file.

3. Details

The Application/Vnd.pwg-multiplexed content-type, like
Multipart/Related, is intended to represent a compound object
consisting of several inter-related components. This document does
not specify the representation of these relationships, but [RFC2557]
contains examples of Multipart/Related entities that use the
Content-ID and Content-Location headers to identify body parts and
URLs (including the "cid" URL) to reference body parts. It is
expected that Application/Vnd.pwg-multiplexed entities would use the
patterns described in [RFC2557].

For an Application/Vnd.pwg-multiplexed entity, there is one parameter
for the Content-Type header. It is a "type" parameter, and it is
like the "type" parameter for the Multipart/Related content-type.
The value of the "type" parameter must be the content-type of the
root message and it effectively specifies the type of the compound
object.

An Application/Vnd.pwg-multiplexed entity contains a sequence of
chunks. Each chunk consists of a chunk header, a chunk payload and a
CRLF.

   - The chunk header consists of a "CHK" keyword followed by the
     message number, the chunk payload length, whether the chunk is
     the last chunk of a message and, finally, a CRLF. The length
     field removes the need for boundary strings that Multipart uses.
     (See section 3.1 for the syntax of a chunk header).

   - The chunk payload is a sequence of octets that is either a
     complete message or a part of a message.

   - The CRLF provides visual separation from the following chunk.

Each message represents a component of the compound object, and a
message is intended to have exactly the same representation, octet
for octet, as a body part of a Multipart/Related entity that
represents the same component. When a message is split across
multiple chunks, the chunks need not be contiguous.

The contents of an Application/Vnd.pwg-multiplexed entity have the
following properties:

   1) The first chunk contains a complete or partial message that (in
      either case) represents the root component of the compound
      object.

2) Additional chunks contain messages or partial messages that
   represent some component of the compound object.

3) The final chunk's header contains a message number of 0, a
   length of 0 and a last-chunk-of-message mark (i.e., the chunk
   header line is "CHK 0 0 LAST"). The final chunk contains no
   chunk payload.

4) A message can be broken into multiple parts and each break can
   occur anywhere within the message. Each part of the message is
   zero or more bytes in length and each part of the message is
   the contents of its own chunk. The order of the chunks within
   the Application/Vnd.pwg-multiplexed entity must be the same as
   the order of the parts within the message.

5) A message represents a component of a compound object, and it
   is intended that it have exactly the same representation, octet
   for octet, as a body part of a Multipart/Related entity that
   represents the same component. In particular, the message may
   contain a Content-Type header to specify the content-type of
   the message content. Also, the message may contain a Content-
   ID header and/or Content-Location header to identify a message
   that is referenced from within another message. If a message
   contains no Content-Type header, then the message has an
   implicit content-type of "text/plain; charset=us-ascii", cf.
   [RFC2045].

See section 4 for a discussion displaying an Application/Vnd.pwg-
multiplexed entity.

3.1 Syntax of Application/Vnd.pwg-multiplexed Contents

The ABNF [RFC2234] for the contents of an Application/Vnd.pwg-
multiplexed entity is:

```
contents = *chunk finalChunk
chunk      = header payload CRLF
header     = "CHK" SP messageNumber SP length SP isMore CRLF
messageNumber   = 1..2147483647
length   = 0..2147483647
isMore       = "MORE" / "LAST"
payload    = *OCTET
finalChunk = finalHeader CRLF
finalHeader  = "CHK" SP "0" SP "0" SP "LAST" CRLF
```

The messageNumber field specifies the message that the chunk is
associated with. See the end of this section for more details.

The length field specifies the number of octets in the chunk payload
(represented in ABNF as "payload"). The first octet of the chunk
payload is the one immediately following the LF (i.e., final octet)
of the chunk header. The last octet of the chunk payload is the one
immediately preceding the two octets CRLF that end the chunk.

The isMore field has a value of "LAST" for the last chunk of a
message and "MORE" for all other chunks of a message.

Normally each message in an Application/Vnd.pwg-multiplexed entity
has a unique message number, and a message consists of the
concatenation of all the octets from the one or more chunks with the
same message number. The isMore field of the chunk header of the
last chunk of each message must have a value of "LAST" and the isMore
field of the chunk header of all other chunks must have a value of
"MORE".

Two or more messages may have the same message number, though such
reuse of message numbers is not recommended. The chunks with the
same message number represent a sequence of one or more messages
where the isMore field of the chunk header of the last chunk of each
message has a value of "LAST". All chunks whose isMore field of the
chunk header has the value of "MORE" belong to the same message as
the next chunk (in sequence) whose isMore field of the chunk header
has the value of "LAST". In other words, if two messages have the
same message number, the last chunk of the first message must occur
before the first chunk of the second message.

The behavior of the Consumer is undefined if the final Chunk (i.e.,
the Chunk whose chunk header is "CHK 0 0 LAST") occurs before the
last chunk of every message occurs.

Two adjacent chunks usually have different message numbers. However,
they may have the same message number. If two adjacent chunks have
the same message number, the two chunks could be combined into a
single chunk, but they need not be combined.

The number of octets in a chunk payload may be zero, and an
Application/Vnd.pwg-multiplexed entity may contain any number of
chunks with zero octets of chunk payload. For example, the last
chunk of each message may contain zero octets for programming
convenience. As another example, suppose that a particular compound
object format requires that referenced messages occur before the root
message. This document requires that the first chunk of an
Application/Vnd.pwg-multiplexed entity contain the root message or a

part of it. So, the first chunk contains a chunk payload of zero
octets with the first octet of the root message in the second chunk.
That is, all of the message headers of the root message are in the
second chunk. As an extreme but unlikely example, it would be
possible to have a message broken into ten chunks with zero octet
chunk payloads in all chunks except for chunks 4 and 7.

3.2 Parameters for Application/Vnd.pwg-multiplexed

This section defines additional parameters for Application/Vnd.pwg-
multiplexed.

3.2.1 The "type" Parameter

The type parameter must be specified. Its value is the content-type
of the "root" message. It permits a Consumer to determine the
content-type without reference to the enclosed message. If the value
of the type parameter differs from the content-type of the root
message, the Consumer's behavior is undefined.

3.2.2 Syntax

The syntax for "parameter" is:

    parameter   := "type" "=" type "/" subtype ; cf. [RFC2045]

4. Handling Application/Vnd.pwg-multiplexed Entities

The application that handles the Application/Vnd.pwg-multiplexed
entity has the responsibility for displaying the entity. However,
Application/Vnd.pwg-multiplexed messages may contain Content-
Disposition headers that provide suggestions for the display and
storage of a message, and in some cases the application may pay
attention to such headers.

As a reminder, Content-Disposition headers [RFC1806] allow the sender
to suggest presentation styles for MIME messages. There are two
presentation styles, 'inline' and 'attachment'. Content-Disposition
headers have a parameter for specifying a suggested file name for
storage.

There are three cases to consider for handling Application/Vnd.pwg-
multiplexed entities:

    a) The Consumer recognizes Application/Vnd.pwg-multiplexed and the
       content-type of the root. The Consumer determines the
       presentation style for the compound object; it handles the
       display of the components of the compound object in the context

of the compound object. In this case, the Content-Disposition
header information is redundant or even misleading, and the
Consumer shall ignore them for purposes of display. The
Consumer may use the suggested file name if the entity is
stored.

b) The Consumer recognizes Application/Vnd.pwg-multiplexed, but
not the content-type of the root. The Consumer will give the
user the choice of suppressing the entire Application/Vnd.pwg-
multiplexed entity or treating the Application/Vnd.pwg-
multiplexed entity as a Multipart/Mixed entity where each
message is a body part of the Multipart/Mixed entity. In this
case (where the entity is not suppressed), the Consumer may
find the Content-Disposition information useful for displaying
each body part of the resulting Multipart/Mixed entity. If a
body part has no Content-Disposition header, the Consumer
should display the body part as an attachment.

c) The Consumer does not recognize Application/Vnd.pwg-
multiplexed. The Consumer treats the Application/Vnd.pwg-
multiplexed entity as opaque and can do nothing with it.

5. Examples

This section contains five examples. Each example is a different
representation of the same compound object. The compound object has
four components: an XHTML text component and three image components.
The images are encoded in binary. The string "<<binary data>>" and
"<<part of binary data>>" in each example represents all or part of
the binary data of each image. Two of the images are potentially
side by side and the third image is displayed later in the document.
All of the images are identified by Content-Id and two of the images
are also identified by a Content-Location. One of the images
references the Content-Location.

The first example shows a Multipart/Related representation of the
compound object in order to provide a representation that the reader
is familiar with. The remaining examples show Application/Vnd.pwg-
multiplexed representations of the same compound object. In the
second example, each chunk contains a whole message. In the third
example, the XHTML message is split across 3 chunks, and these chunks
are interleaved among the three image messages. In the fourth
example, the XHTML message is split across 4 chunks, and the two
side-by-side images are each split across two chunks. The XHTML
chunks are interleaved among the image chunks. In the fifth example,
there are chunks with empty payloads and adjacent chunks with the
same message number.

The last example may seem to address useless cases, but sometimes it
is easier to write software if these cases are allowed. For example,
when a buffer fills, it may be easiest to write a chunk and not worry
if the previous chunk had the same message number. Likewise, it may
be easiest to end a message with an empty chunk. Finally, the
Application/Vnd.pwg-multiplexed content-type requires that the first
chunk be part of the root message. Sometimes, it is more convenient
for the Producer if the root message starts after the occurrence of
some attachments. Since a chunk can be empty, the first chunk of the
root message can be empty, i.e., it doesn't even contain any headers.
Then the first chunk contains a part of the root message, but the
Producer doesn't generate any octets for that chunk.

Each body part of the Multipart/Related entity and each message of
the Application/Vnd.pwg-multiplexed entity contain a content-
disposition, which the Consumer uses according to the rules in
section 4. Note the location of the content-disposition headers in
the examples.

5.1 Example With Multipart/Related

In this example, the compound object is represented as a
Multipart/Related entity so that the reader can compare it with the
Application/Vnd.pwg-multiplexed entities.

```
Content-Type: multipart/related; boundary="boundary-example";
              type="text/xhtml+xml"

--boundary-example
Content-ID: <49568.44343xxx@foo.com>
Content-Type: application/vnd.pwg-xhtml-print+xml
Content-Disposition: inline

<?xml version="1.0"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/TR/xhtml1">
   <body>
      <p>some text
         <img src="cid:49568.45876xxx@foo.com"/>
         <img src="http://foo.com/images/image2.gif"/>
         some more text after the images
      </p>
      <p>some more text without images
      </p>
      <p>some more text
         <img src="cid:49568.47333xxx@foo.com"/>
      </p>
```

```
      <p>some final text
      </p>
   </body>
</html>
--boundary-example
Content-ID: <49568.45876xxx@foo.com>
Content-Location: http://foo.com/images/image1.gif
Content-Type: image/gif
Content-Disposition: attachment

<<binary data>>
--boundary-example
Content-ID: <49568.46000xxx@foo.com>
Content-Location: http://foo.com/images/image2.gif
Content-Type: image/gif
Content-Disposition: attachment

<<binary data>>
--boundary-example
Content-ID: <49568.47333xxx@foo.com>
Content-Type: image/gif
Content-Disposition: attachment

<<binary data>>
--boundary-example--
```

5.2 Examples with Application/Vnd.pwg-multiplexed

   The four examples in this section show Application/Vnd.pwg-
   multiplexed representations of the same compound object. Note that
   each CRLF is represented by a visual line break.

5.2.1 Example Where Each Chunk Has a Complete Message

   In this example, the compound object is represented as an
   Application/Vnd.pwg-multiplexed entity. Each chunk contains an
   entire message, i.e., none of the messages are split across multiple
   chunks. Each message in this example is identical to the
   corresponding body part in the preceding Multipart/Relate example.

```
   Content-Type: application/vnd.pwg-multiplexed;
               type="application/vnd.pwg-xhtml-print+xml"

   CHK 1 550 LAST
   Content-ID: <49568.44343xxx@foo.com>
   Content-Type: application/vnd.pwg-xhtml-print+xml
   Content-Disposition: inline
```

```
<?xml version="1.0"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/TR/xhtml1">
    <body>
        <p>some text
            <img src="cid:49568.45876xxx@foo.com"/>
            <img src="http://foo.com/images/image2.gif"/>
            some more text after the images
        </p>
        <p>some more text without images
        </p>
        <p>some more text
            <img src="cid:49568.47333xxx@foo.com"/>
        </p>
        <p>some final text
        </p>
    </body>
</html>

CHK 2 6346 LAST
Content-ID: <49568.45876xxx@foo.com>
Content-Location: http://foo.com/images/image1.gif
Content-Type: image/gif
Content-Disposition: attachment

<<binary data>>
CHK 3 6401 LAST
Content-ID: <49568.46000xxx@foo.com>
Content-Location: http://foo.com/images/image2.gif
Content-Type: image/gif
Content-Disposition: attachment

<<binary data>>
CHK 4 7603 LAST
Content-ID: <49568.47333xxx@foo.com>
Content-Type: image/gif
Content-Disposition: attachment

<<binary data>>
CHK 0 0 LAST
```

5.2.2 Example of Chunking the Root Message

   In this example, the compound object is represented as an
   Application/Vnd.pwg-multiplexed entity. The message containing the
   XHTML component is split into 3 pieces so that the reference to an
   image is as close as possible to the beginning of the chunk. The
   chunk containing the referenced image message occurs just before the
   chunk with the reference. This minimizes the distance between
   reference and referenced message.

   Note that there are other possible arrangements (see the third
   example in section 5.2.3). For example, a sender could split the
   XHTML message so that the reference to an image is as close as
   possible to the end of the chunk. Then the chunk containing the
   referenced image message should occur just after the chunk with the
   reference. The sender could mix this strategy with the one used in
   this example.

   Content-Type: application/vnd.pwg-multiplexed;
               type=" application/vnd.pwg-xhtml-print+xml"

   CHK 1 267 MORE
   Content-ID: <49568.44343xxx@foo.com>
   Content-Type: application/vnd.pwg-xhtml-print+xml
   Content-Disposition: inline

   <?xml version="1.0"?>
   <!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
       "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
   <html xmlns="http://www.w3.org/TR/xhtml1">
      <body>
         <p>some text

   CHK 2 6346 LAST
   Content-ID: <49568.45876xxx@foo.com>
   Content-Location: http://foo.com/images/image1.gif
   Content-Type: image/gif
   Content-Disposition: attachment

   <<binary data>>
   CHK 3 6401 LAST
   Content-ID: <49568.46000xxx@foo.com>
   Content-Location: http://foo.com/images/image2.gif
   Content-Type: image/gif
   Content-Disposition: attachment

```
   <<binary data>>
   CHK 1 166 MORE
           <img src="cid:49568.45876xxx@foo.com"/>
           <img src="http://foo.com/images/image2.gif"/>
           some more text after the images
       </p>
       <p>some more text without images
       </p>
       <p>some more text

   CHK 4 7603 LAST
   Content-ID: <49568.47333xxx@foo.com>
   Content-Type: image/gif
   Content-Disposition: attachment

   <<binary data>>
   CHK 1 80 LAST
           <img src="cid:49568.47333xxx@foo.com"/>
       </p>
       <p>some final text
       </p>
     </body>
   </html>

   CHK 0 0 LAST
```

5.2.3 Example of Chunking the Several Messages

   In this example, the compound object is represented as an
   Application/Vnd.pwg-multiplexed entity. The message containing the
   XHTML component is split into 4 pieces so that the reference to an
   image is as close as possible to either the beginning or the end of
   the chunk. The references to the first and second images closely
   follow the referenced images. The reference to the third image
   closely precedes the referenced image. This minimizes the distance
   between reference and referenced message. In addition, the first two
   image messages are split into two chunks each.

```
   Content-Type: application/vnd.pwg-multiplexed;
               type=" application/vnd.pwg-xhtml-print+xml"

   CHK 1 303 MORE
   Content-ID: <49568.44343xxx@foo.com>
   Content-Type: application/vnd.pwg-xhtml-print+xml
   Content-Disposition: inline
```

```
<?xml version="1.0"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/TR/xhtml1">
   <body>
      <p>some text

CHK 2 184 MORE
Content-ID: <49568.45876xxx@foo.com>
Content-Location: http://foo.com/images/image1.gif
Content-Type: image/gif
Content-Disposition: attachment

<<part of binary data>>
CHK 3 200 MORE
Content-ID: <49568.46000xxx@foo.com>
Content-Location: http://foo.com/images/image2.gif
Content-Type: image/gif
Content-Disposition: attachment

<<part of binary data>>
CHK 1 78 MORE
         <img src="cid:49568.45876xxx@foo.com"/>
         <img src="http://foo.com/images/image2.gif"/>

CHK 2 6162 LAST
<<part of binary data>>
CHK 3 6201 LAST
<<part of binary data>>
CHK 1 127 MORE
         some more text after the images
      </p>
      <p>some more text without images
      </p>
      <p>some more text
         <img src="cid:49568.47333xxx@foo.com"/>

CHK 4 7603 LAST
Content-ID: <49568.47333xxx@foo.com>
Content-Type: image/gif
Content-Disposition: attachment
```

```
     <<binary data>>
     CHK 1 41 LAST
           </p>
           <p>some final text
           </p>
        </body>
     </html>

     CHK 0 0 LAST
```

5.2.4 Example of Chunks with Empty Payloads

This example is identical to the previous one, except that some
chunks have a chunk payload of zero octets. The root message starts
with a chunk whose payload is empty and every message ends with a
chunk whose payload is empty. This example also shows two adjacent
chunks that are from the same message. These two chunks could be
coalesced into a single chunk, but they might be kept separate for
programming convenience.

```
     Content-Type: application/vnd.pwg-multiplexed;
                 type=" application/vnd.pwg-xhtml-print+xml"

     CHK 1 0 MORE

     CHK 2 184 MORE
     Content-ID: <49568.45876xxx@foo.com>
     Content-Location: http://foo.com/images/image1.gif
     Content-Type: image/gif
     Content-Disposition: attachment

     <<part of binary data>>
     CHK 3 200 MORE
     Content-ID: <49568.46000xxx@foo.com>
     Content-Location: http://foo.com/images/image2.gif
     Content-Type: image/gif
     Content-Disposition: attachment

     <<part of binary data>>
     CHK 1 303 MORE
     Content-ID: <49568.44343xxx@foo.com>
     Content-Type: application/vnd.pwg-xhtml-print+xml
     Content-Disposition: inline
```

```
<?xml version="1.0"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/TR/xhtml1">
   <body>
      <p>some text

CHK 2 6162 MORE
<<part of binary data>>
CHK 3 6201 MORE
<<part of binary data>>
CHK 2 0 LAST

CHK 3 0 LAST

CHK 1 78 MORE
         <img src="cid:49568.45876xxx@foo.com"/>
         <img src="http://foo.com/images/image2.gif"/>

CHK 4 7603 MORE
Content-ID: <49568.47333xxx@foo.com>
Content-Type: image/gif
Content-Disposition: attachment

<<binary data>>
CHK 4 0 LAST

CHK 1 127 MORE
         some more text after the images
      </p>
      <p>some more text without images
      </p>
      <p>some more text
         <img src="cid:49568.47333xxx@foo.com"/>

CHK 1 41 MORE
      </p>
      <p>some final text
      </p>
   </body>
</html>

CHK 1 0 LAST

CHK 0 0 LAST
```

6. Security Considerations

   There are security considerations that pertain to each message of an
   Application/Vnd.pwg-multiplexed entity. Those security
   considerations are described by the document that defines the
   content-type of the message. They are not addressed in this
   document.

   There are also security considerations that pertain to the
   Application/Vnd.pwg-multiplexed entity as a whole. A Producer that
   is buggy or malicious may send an Application/Vnd.pwg-multiplexed
   entity that could cause a Consumer to request more storage than it
   has, even if it has a large amount of storage. A Consumer must be
   able to deal gracefully with the following scenarios and combinations
   of them:

      - The chunks of one or more messages are separated by a very large
        number of octets. In the extreme case some or all of the
        messages don't terminate, i.e., they don't contain a closing
        chunk.
      - A very large number of messages are started and interleaved
        before their final chunk occurs.
      - A message contains one or more references to other messages that
        never occur or don't occur for a large number of octets.
      - A very large number of referenced messages occur before the
        Consumer knows that it can discard them.

7. Registration Information for Application/Vnd.pwg-multiplexed

   The following form is copied from RFC 1590, Appendix A.

      To: iana@iana.org

      Subject: Registration of new Media Type
                          application/Vnd.pwg-multiplexed
      Media Type name: Application
      Media subtype name: Vendor Tree - vnd.pwg-multiplexed
      Required parameters: Type, a media type/subtype.
      Optional parameters: No optional parameters
      Encoding considerations: Each message of an
                          Application/Vnd.pwg-multiplexed entity can be
                          encoded in any manner allowed by the Content-
                          Type of the message. However, using the
                          reasoning of Multipart, the
                          Application/Vnd.pwg-multiplexed entity cannot
                          be encoded. Otherwise, a message would be

                             encoded twice, once at the message level and
                             once at the Application/Vnd.pwg-multiplexed
                             level.
        Security considerations: See section 6 (Security
                                     Considerations) of RFC 3391.
        Published specification: RFC 3391.
        Person & email address to contact for further information:

            Robert Herriot
            706 Colorado Ave.
            Palo Alto, CA 94303
            USA
            Phone: 1-650-327-4466
            Fax: 1-650-327-4466
            EMail: bob@herriot.com

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11. Full Copyright Statement

Acknowledgement