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Payload Format for JPEG 2000 Video: Extensions for Scalability and Main
Header Recovery
[draft-ietf-avt-rtp-jpeg2000-beam-05](#)

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Abstract

This memo describes extended uses for payload header in RFC document: "RTP Payload Format for JPEG 2000 Video Streams." For better support of JPEG 2000 features such as scalability and includes a main header recovery method.

This memo MUST be accompanied with a complete implementation of "RTP Payload Format for JPEG 2000 Video Streams." That document is a complete description of the payload header and signaling, this document only describes additional processing for the payload header. There is an additional media type and SDP marker signaling for implementations of this document.

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1. Introduction

This document is an extension of: "RTP Payload Format for JPEG 2000 Video Streams"[[1](#)]. These are additional mechanisms that can be used with certain parts of the header in [[1](#)] to support JPEG 2000 features such as scalability and a main header compensation method. These mechanisms are described in detail in this document.

1.1. History

In the development of RFC XXXY [[1](#)], there was an issue of IPR claims on certain mechanisms with main header compensation, priority table usage, etc. in RFC XXXY [[1](#)]. As these are not "essential" to the core RTP format of RFC XXXY [[1](#)] and only describes a mechanism, it was decided that splitting these mechanisms from the core JPEG 2000 RTP format in to a separate document. This is the document describing the IPR related mechanisms for main header recover and priority table usage.

1.2. Description of the Mechanisms

1.2.1. Main Header Compensation

JPEG 2000's scalable coding scheme allows for decompressing truncated or partial data streams but only when the main header is present. If the header is lost, the data is useless. With JPEG 2000 video coding, coding parameters between frames will rarely change and previous headers may be used in newly received data which the header have been lost.

Compensation of the main header that has been lost is very simple with this procedure. In the case of JPEG 2000 video, it is very common that encode parameters will not vary greatly between successive frames. Even if the RTP packet including the main header of a frame has been dropped, decoding may be performed by using the main header of a prior frame.

1.2.2. Priority Table

JPEG 2000 codestream has rich functionality built into it so decoders can easily handle scalable delivery or progressive transmission. Progressive transmission allows images to be reconstructed with increasing pixel accuracy or spatial resolution. This feature allows the reconstruction of images with different resolutions and pixel accuracy, for different target devices. A single image source can provide a codestream that is easily processed for smaller image display devices.

JPEG 2000 packets contain all compressed image data from a specific: layer, component, resolution level, and/or precinct. The order in which these JPEG 2000 packets are found in the codestream is called: progression order. The ordering of the JPEG 2000 packets can progress along four axes: layer, component, resolution and precinct (or position).

Providing a priority field to indicate the importance of data contained in a given RTP packet can aid in usage of JPEG 2000 progressive and scalable functions.

1.3. Motivations for Priority Field coding

JPEG 2000 coding scheme allows one to reorder the codestream in many ways. Even when the coding scheme is determined and arranged by the encoder, a decoder can still re-arrange the code stream on the fly to suit decode parameters such as: re-arranging from resolution progressive to quality progressive.

Using the priority field coding, the decoder gains insight into the codestream without access to the full codestream and exposes features of JPEG 2000 to a higher level.

A few of the scenarios are presented below the authors have thought of to utilize this field. The priority field allows more information about the image to be sent without more signaling between sender and receivers to leverage JPEG 2000 capabilities.

1.3.1. Scenario: Just enough resolution

The scenario is when rapid scene access is more important than higher quality. By using the priority field, the receiver can decode for its own quality level. If the sender cannot determine the receiver's resolution, the receiver can select which parts of the codestream to decode/load by using the priority field.

1.3.2. Scenario: Multiple clients, single source

In a multicast environment, there are clients with better visual capability than others (i.e. TV conference vs. Mobile). The respective clients can use the priority field to determine which packets are vital for their own visual presentation. The sender will have to do work on the priority field to optimally serve all the clients while only managing a single visual stream.

1.4. Conventions Used in This Document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119](#). [2].

RFC-Editor Note: The RFC Editor is requested to replace all occurrences of RFC XXXY with the RFC number [draft-ietf-avt-rtp-jpeg2000](#) receives. At that time, please remove this note.

2. Payload Format Enhanced Processing

2.1. Enhanced Processing Markers

This section of the document describes additional usage in the values of mh_id and priority fields and interpretation which differ from RFC XXXY [1]. Implementations of this document should follow RFC XXXY [1] first then add additional header processing as described in this document. Implementations following this document are expected to interoperate with implementations of [1] and this document as well.

The RTP payload header format for JPEG 2000 video stream is as follows:

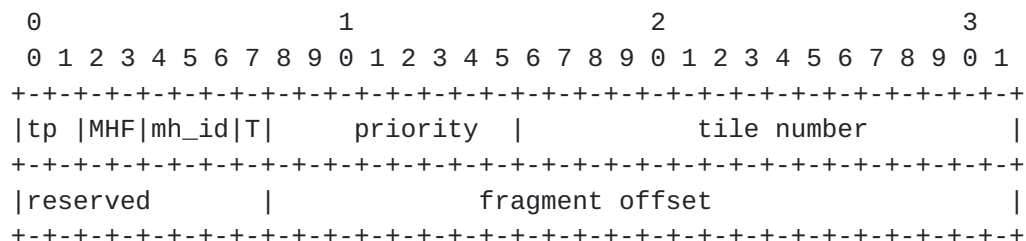


Figure 1: RTP payload header format for JPEG 2000

mh_id (Main Header Identification) : 3 bits

Main header identification value. This is used for JPEG 2000 main header recovery.

The initial value of mh_id is random, and may take any value between 1-7, but MUST NOT be 0.

The same mh_id value is used as long as the coding parameters described in the main header remains unchanged between frames.

The mh_id value MUST be incremented by 1 every time a new main header is transmitted. Once the mh_id value becomes greater than 7, it SHOULD roll over to 1.

When mh_id is 0, it has special usage for the receiver. This special usage is described in [Section 4.2](#) of this document.

Senders should follow [Section 4.1](#) of this document for proper mh_id assignment and usage.

priority : 8 bits

The priority field indicates the importance of the JPEG 2000 packet included in the payload. Typically, a higher priority is set in the packets containing JPEG 2000 packets containing the lower sub-bands.

Special values of priority:

0: This is reserved for payload which contain a header (main or tile part header.) This is considered the most important.

1 to 255: These values decrease in importance as the values increase. (i.e. 1 is more important than 2, etc.) Applying priority values should correlate directly to JPEG 2000 codestream in importance.

The lower the priority value is the higher the importance. A priority value of 0 is the highest importance and 255 is the lowest importance. We define the priority value 0 as a special priority value for the headers (the main header or tile-part header). If any headers (the main header or tile-part header) are packed into the RTP payload, the sender MUST set the priority value to 0.

Assignment of the values are described in [Section 3](#) with pre-defined table assignments in [Section 3.1](#).

3. Priority Mapping Table

For the progression order, the priority value for each JPEG 2000 packet is given by the priority mapping table.

3.1. Pre-Defined Priority Mapping

This document specifies several commonly-used priority mapping tables, pre-defined priority mapping tables: packet number based (default), progression-based, layer-based, resolution-based, position-based, and component-based.

Packet number priority mapping is REQUIRED to be supported by clients implementing this specification. Other priority mapping tables (progression, layer, resolution, and component based) are OPTIONAL to implementations of this specification.

Rules that all implementations of this specification MUST follow in all priority modes:

- o When there is a header in the packet with a JPEG 2000 packet, the sender MUST set the payload packet priority value to 0.
- o When there are multiple JPEG 2000 packets in the same RTP payload packet, the sender MUST set the payload packet priority value to the lowest JPEG 2000 packet. (i.e. if JPEG 2000 packets with priority: 5,6,7 are packed into a single payload, the priority value will be 5.)

3.1.1. Packet Number Based Ordering

Packet number based ordering assigns the payload packet priority value from the "JPEG 2000 packet value". (note: JPEG 2000 codestreams are stored in units of packets and each packet has a value .) This method is the default method for assigning priority value. All implementations of this specification MUST support this method.

If the JPEG 2000 codestream packet value is greater than 255, the sender MUST set the payload priority value to 255.

3.1.2. Progression Based Ordering

The sender will assign the payload packet priority value only based on layer, resolution, and component ordering of the codestream.

This is similar to the packet number based assignment but will not take into account the precinct number or position in the JPEG 2000 codestream.

For example:

If the codestream is ordered in LRCP (Layer, Resolution, Component, Position)

All the packets in:

layer.....[0](#)
resolution....[0](#)
component.....[0](#)

then the packet priority value : 1

All the packets in:

layer.....[0](#)
resolution....[0](#)
component.....[1](#)

then the packet priority value : 2

All the packets in:

layer.....[0](#)
resolution....[0](#)
component.....[2](#)

then the packet priority value : 3

[3.1.3.](#) Layer Based Ordering

Layer-based priority mapping table simplifies the default mapping to just matching JPEG 2000 packets together from the same layer.

For example:

All the packets in layer 0 : packet priority value : 1
All the packets in layer 1 : packet priority value : 2
All the packets in layer 2 : packet priority value : 3
...
All the packets in layer n : packet priority value : n+1
All the packets in layer 255 : packet priority value : 255

[3.1.4.](#) Resolution Based Ordering

Resolution-based priority mapping table is similar to the layer based order but for JPEG 2000 packets of the same resolution

For example:

```
All the packets in resolution 0 : packet priority value : 1
All the packets in resolution 1 : packet priority value : 2
All the packets in resolution 2 : packet priority value : 3
...
All the packets in resolution n : packet priority value : n+1
All the packets in resolution 255 : packet priority value : 255
```

3.1.5. Component Based Ordering

Component-based priority mapping table is mapping together JPEG 2000 components of the same component

For example:

```
All the packets in component 0 : packet priority value : 1
All the packets in component 1 : packet priority value : 2
All the packets in component 2 : packet priority value : 3
...
All the packets in component n : packet priority value : n+1
All the packets in component 255 : packet priority value : 255
```


4. JPEG 2000 Main Header Compensation Scheme

The mh_id field of the payload header is used to indicate whether the encoding parameters of the main header are the same as the encoding parameters of the previous frame. The same value is set in mh_id of the RTP packet in the same frame. The mh_id and encode parameters are not associated with each other as 1:1 but they are used to indicate whether the encode parameters of the previous frame are the same or not in the event of a lost header.

The mh_id field value SHOULD be saved from previous frames to be used to recover the current frame's main header. If the mh_id of the current frame has the same value as the mh_id value of the previous frame, the previous frame's main header MAY be used to decode the current frame, in case of a lost header in the current frame.

The sender MUST increment mh_id when parameters in the header change and send a new main header accordingly.

The receiver MAY use the mh_id and MAY retain the header for such compensation.

4.1. Sender Processing

The sender MUST transmit RTP packets with the same mh_id value if the encoder parameters of the current frame are the same as the previous frame. The encoding parameters are the fixed information marker segment (SIZ marker) and functional marker segments (COD, COC, RGN, QCD, QCC, and POC) specified in JPEG 2000 Part 1 Annex A [3].

An initial value of mh_id MUST be selected randomly between 1 and 7 for security reasons.

If the encode parameters changes, the sender transmitting RTP packets MUST increment the mh_id value by one, but when mh_id value becomes greater than 7, a sender MUST set mh_id value back to 1.

4.2. Receiver Processing

When the receiver receives the main header completely, the RTP sequence number, the mh_id and main header should be saved. Only the last main header that was received completely SHOULD be saved. When the mh_id value is 0, the receiver SHOULD NOT save the header.

When the main header is not received, the receiver may compare the current payload header's mh_id value with the previous saved mh_id value. If the values match, decoding may be performed by using the previously saved main header.

If the `mh_id` field is set to 0, the receiver MUST NOT save the main header and MUST NOT compensate for lost headers.

If the `mh_id` value changes, receivers SHOULD save the current header and save the new `mh_id` value. The old saved header should be deleted from storage.

5. Security Consideration

Please refer to [section 6](#) of RFC XXXY [[1](#)] for Security Considerations regarding this RTP format.

6. Congestion Control

Please refer to [section 7](#) of RFC XXXY [[1](#)] for Congestion Control regarding this RTP format.

[7.](#) IANA Consideration

[7.1.](#) Media Type Registration

This document extends the associated media type from RFC XXXY[1]:
Here is the complete original for reference.

This registration uses the template defined in [\[7\]](#) and follows [\[8\]](#).

Type name: video

Subtype name: jpeg2000

Required parameters:

sampling: A list of values specifying the color space of the
payload data.

Acceptable values:

RGB: standard Red, Green, Blue color space.

BGR: standard Blue, Green, Red color space.

RGBA: standard Red, Green, Blue, Alpha color space.

BGRA: standard Blue, Green, Red, Alpha color space.

YCbCr-4:4:4: standard YCbCr color space, no subsampling.

YCbCr-4:2:2: standard YCbCr color space, Cb and Cr are
subsampling horizontally by 1/2.

YCbCr-4:2:0: standard YCbCr color space, Cb and Cr are
subsampling horizontally and vertically by 1/2.

YCbCr-4:1:1: standard YCbCr color space, Cb and Cr are
subsampling vertically by 1/4

GRAYSCALE: basically a single component image of just
multilevels of grey.

EXTENSION VALUE: Additional color samplings can be registered
with and current listing of registered color samplings at:
Color Sampling Registration Authority. Please refer to RTP
Format for Uncompressed Video. [\[9\]](#)

Optional parameters:

interlace: interlace scanning. If payload is in interlace format, the acceptable value is "1", otherwise, the value should be "0". Each complete image forms vertically half the display. tp value MUST properly specify the field the image represents odd(tp=1), or even(tp=2). If this option is not present, the payload MUST be in progressive format and tp MUST be set to 0.

width: A parameter describing the maximum width of the video stream. This parameter MUST appear when height is present. Acceptable values: - an integer value between 0 - 4,294,967,295.

height: A parameter describing the maximum height of the video stream. This parameter MUST appear when width is present. Acceptable values: - an integer value between 0 - 4,294,967,295.

The receiver MUST ignore any unspecified parameters outside of this list and in [\[1\]](#) .

Additional parameters for this extension:

mhc : Main Header Compensation. this option is used when sender and/or receiver is utilizing the Main Header compensation technique as specified in this document. Acceptable values when using the Main Header compensation technique is "1", otherwise, it should be "0".

This is a list of options to be included when the sender or receiver is utilizing the Priority Table(s) as specified in this document.

pt : Priority Table. this option is followed by a comma-separated list of predefined priority table definitions to be used by sender or receiver.

The option appearing front most in the option line is the most important and next ones are of decreasing importance.

Acceptable values:

progression : this table follows the progression ordering of the codestream.

layer : this table follows the layer ordering of the codestream.

resolution : this table follows the resolution ordering of the codestream.

component : this table follows the component ordering of the codestream.

default : this table follows the ordering of the codestream.

Encoding considerations:

This media type is framed and binary, see Section 4.8 in [\[7\]](#)

Security considerations:

see security considerations section [Section 5](#) of this document.

Interoperability considerations:

JPEG 2000 video stream is a sequence of JPEG 2000 still images. An implementation in compliant with [\[3\]](#) can decode and attempt to display the encoded JPEG 2000 video stream.

Published specification: ISO/IEC 15444-1 | ITU-T Rec. T.800

Applications which use this media type:

video streaming and communication

Person and email address to contact for further information:

Eisaburo Itakura, Satoshi Futemma, Andrew Leung
Email: {itakura|satosi-f} @ sm . sony . co . jp, andrew @ ualberta . net

Intended usage: Restriction

Restrictions on Usage:

This media type depends on RTP framing, and hence is only defined for the transfer via RTP [\[4\]](#). Transport within other framing protocols is not defined at the time.

Author/Change Controller:

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Change controller:

IETF Audio/Video Transport Working Group delegated from the
IESG

7.2. SDP Parameters

In addition to SDP Parameters section in [\[1\]](#):

The media type video/jpeg2000 string is mapped to fields in the Session Description Protocol (SDP) [\[5\]](#) as follows:

- o The media name in the "m=" line of SDP MUST be video.
- o The encoding name in the "a=rtpmap" line of SDP MUST be jpeg2000 (the MIME subtype).
- o The clock rate in the "a=rtpmap" line MUST be 90000.
- o The OPTIONAL parameters "mhc" or "pt" MUST be included in the "a=fmtp" line of SDP.

These parameters are expressed as a media type string, in the form of a semicolon separated list of parameter=value pairs.

Therefore, an example of media representation in SDP is as follows:

```
m=video 49170/2 RTP/AVP 98
a=rtpmap:98 jpeg2000/90000
a=fmtp:98 mhc; pt=default; sampling=YCbCr-
4:2:0;width=128;height=128
```


8. Usage with the SDP Offer/Answer Model

In addition to SDP Offer/Answer section in RFC XXXY [[1](#)]:

When offering JPEG 2000 over RTP using SDP in an Offer/Answer model [[6](#)], the following rules and limitations apply:

- o All parameters MUST have an acceptable value for that parameter.
- o All parameters MUST correspond to the parameters of the payload.
- o The parameters "mhc" or "pt" MUST appear in the offer and answer. If the parameter "mhc" or "pt" is not in the answer, senders should not process the header according to this document.
- o For the "pt" option:
 - * Senders should send a complete list indicating which option are available to the receiver. The receiver should answer with their preference from the offer list.
- o In a multicast environment:
 - * Senders should send out one option for priority-table-definition for everyone in the group.
 - * If a single client in the group do not support the extensions outlined in this document, senders SHOULD NOT use additional techniques outlined in this document.

This is highly recommended for multicast streams where not all receivers are of the same type.

8.1. Examples

Offer/Answer example exchanges are provided.

8.1.1. Example 1

Alice offers Main Header Compensation functionality, YCbCr 422 color space, interlace image with 720-pixel width and 480-pixel height and several priority-table options (default, progression, layer, resolution, component) as below:

```
v=0
o=alice 2890844526 2890844526 IN IP4 host.exempl
s=
c=IN IP4 host.exempl
```



```
t=0 0
m=video 49170 RTP/AVP 98
a=rtpmap:98 jpeg2000/900000
a=fmtp:98 mhc=1;sampling= YCbCr-4:2:2;interlace=1
a=fmtp:98 pt=default, progression,layer, resolution, component;
width=720; height=480
```

Bob accepts Main Header Compensation functionality, YCbCr-4:2:2 color space, interlace image, default mapping table and replies:

```
v=0
o=bob 2890844730 2890844731 IN IP4 host.example
s=
c=IN IP4 host.example
t=0 0
m=video 49920 RTP/AVP 98
a=rtpmap:98 jpeg2000/900000
a=fmtp:98 mhc=1;sampling= YCbCr-4:2:2;interlace=1
a=fmtp:98 mhc=1; pt=default; width=720;height=480
```

8.1.2. Example 2

Alice offers Main Header Compensation, YCbCr 420 color space, progressive image with 320-pixel width and 240-pixel height and layer priority-table options as below:

```
v=0
o=alice 2890844526 2890844526 IN IP4 host.example
s=
c=IN IP4 host.example
t=0 0
m=video 49170 RTP/AVP 98
a=rtpmap:98 jpeg2000/900000
a=fmtp:98 mhc=1;sampling= YCbCr-4:2:0
a=fmtp:98 pt=layer; width=320; height=240
```

Bob does not accept Main Header Compensation functionality but accepts YCbCr-4:2:0 color space, layer based priority mapping and replies:

```
v=0
o=bob 2890844730 2890844731 IN IP4 host.example
s=
c=IN IP4 host.example
t=0 0
m=video 49920 RTP/AVP 98
a=rtpmap:98 jpeg2000/900000
a=fmtp:98 mhc=1;sampling= YCbCr-4:2:0
```



```
a=fmtp:98 mhc=0;  
a=fmtp:98 pt=layer; width=320; height=240
```

9. References

9.1. Normative References

- [1] Futemma, "RTP Payload Format for JPEG 2000 Video Streams", RFC XXXY, April 2007.
- [2] Bradner, "Key words for use in RFCs to Indicate Requirement Levels", [RFC 2119](#), March 1997.
- [3] ISO/IEC JTC1/SC29, ISO/IEC 15444-1 | ITU-T Rec. T.800, "Information Technology - JPEG 2000 Image Coding System - Part 1: Core Coding System", December 2000.
- [4] Schulzrinne, Casner, Frederick, and Jacobson, "RTP: A Transport Protocol for Real Time Applications", [RFC 3550](#), STD 64, July 2003.
- [5] Handley and Jacobson, "SDP: Session Description Protocol", [RFC 2327](#), April 1998.
- [6] Rosenberg and Schulzrinne, "An Offer/Answer Model with Session Description Protocol (SDP)", [RFC 3264](#), June 2002.
- [7] Freed and Klensin, "Media Type Specifications and Registration Procedures", [RFC 4288](#), December 2005.
- [8] Casner and Hoschka, "MIME Type Registration of RTP Payload Formats", [RFC 3555](#), July 2003.

9.2. Informative References

- [9] Perkins and Gharai, "RTP Payload Format for Uncompressed Video", [RFC 2246](#), September 2005.

Appendix A. Sample Headers in Detail

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|tp |MHF|mh_id|T|      priority  |      tile number      |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|reserved      |      fragment offset      |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 2

First Packet: This packet will have the whole main header. 210 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|1 1|1 0 1|1|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF4FFF51002F000 ....|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 3

Second Packet: This packet will have a tile header and the first tile part LLband 1500 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|1 1|1 0 1|0|0 0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 0 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF90 000A 0000 0000 2DB3 0001 FF93|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 4

Third Packet: This packet will have the next part in the tile, no tile header 1500 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|0 0|1 0 1|0|0 0 0 0 0 0 1 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 1 1 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|E841 4526 4556 9850 C2EA .... |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 5

Fourth Packet: Last packet for the image 290 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|0 0|1 0 1|0|0 0 0 0 0 0 1 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1 0 0 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|A55D 8B73 3B25 25C7 B9EB .... 2FBEB153|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 6

First Packet: This packet will have the whole main header. 210 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|1 1|0 0 1|1|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF4FFF51002F000 .... |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 7

Second Packet: This packet will have a first tile part (tile 0) 1400 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|0 0|0 0 1|0|0 0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 0 1 0|
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF90 000A 0000 0000 0578 0001 FF93 ....|
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 8

Third Packet: This packet will have a second tile part (tile 1) 1423 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|0 0|0 0 1|0|0 0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 1|
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1 0 0 1 0 1 0|
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF90 000A 0001 0000 058F 0001 FF93 ....|
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 9

Fourth Packet: This packet will have a third tile part (tile 2) 1355 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|0 0|0 0 1|0|0 0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0|
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 1 1 0 1 1 0 0 1|
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF90 000A 0002 0000 054B 0001 FF93 ....|
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 10

Fifth Packet: This packet will have a fourth tile part (tile 3) 1290 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|0 0|0 0 1|0|0 0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 1 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF90 000A 0003 0000 050A 0001 FF93      ....      |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 11

First Packet: This packet will have the first part of the main header. 110 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|0 1|0 0 0|1|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF4FFF51002F000 ....      |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 12

Second Packet: This packet has the second part of the header. 1400 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|1 0|0 0 0|1|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 1 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF6400FF ....      |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 13

Third Packet: This packet has two tiles, tile 0 and tile 1 1400 bytes

```

      0              1              2              3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|0 0|0 0 0|1|0 0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 1 1 0 0 1 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF90 000A 0000 0000 02BC 0001 FF93 ...|
|FF90 000A 0001 0000 02BC 0001 FF93 ...|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 14

Fourth Packet: This packet has one tile, tile 2 1395 bytes

```

      0              1              2              3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0|0 0|0 0 0|0|0 0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 0 1 1 1 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF90 000A 0002 0000 0573 0001 FF93 ....|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 15

First packet: This packet will have the whole main header for the odd field 210 bytes

```

      0              1              2              3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 1|1 1|0 1 0|1|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF4FFF51002F000 ....|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 16

Second packet: This packet will have the first part of the odd field's tile 1400 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 1|0 0|0 1 0|1|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 0 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF90 000A 0000 0000 0578 0001 FF93 ....|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 17

Third packet: This packet will have the second part of the odd field's tile 1400 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 1|0 0|0 1 0|1|0 0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1 0 0 1 0 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|7F04 E708 27D9 D11D 22CB ...|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 18

Fourth packet: This packet will have the third part of the odd field's tile 1300 bytes

```

      0              1              2              3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 1|0 0|0 1 0|1|0 0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 1 1 0 0 0 0 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|98BD EC9B 2826 DC62 D4AB ...|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 19

Fifth packet: This packet will have the whole main header for the even field

```

      0              1              2              3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|1 0|1 1|0 1 1|1|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF4FFF51002F000 ....|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 20

Sixth packet: This packet will have the first part of the odd field's tile 1400 bytes

```

      0              1              2              3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|1 0|0 0|0 1 0|1|0 0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 0 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|FF90 000A 0000 0000 0578 0001 FF93 ....|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 21

Seventh packet: This packet will have the second part of the odd field's tile 1400 bytes

```

      0              1              2              3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|1 0|0 0|0 1 0|1|0 0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1 0 0 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|626C 42F0 166B 6BD0 F8E1 ...|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 22

Eighth packet: This packet will have the third part of the odd field's tile 1300 bytes

```

      0              1              2              3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|1 0|0 0|0 1 0|1|0 0 0 0 0 0 0 1|0 0 0 0 0 0 0 0 0 0 0 0 0 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|0 0 0 0 0 0 0 0|0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 1 0 0 0 0 1 0|
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|8114 41D5 18AB 4A1B ...                                     |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Figure 23

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