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Part 9: Interactivity tools, APIs and protocols

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Partie 9: Outils d'interactivité, interfaces de programmes d'application et protocoles

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Introduction

Rec. ITU-T T.800 | ISO/IEC 15444-1 (JPEG 2000) is a specification that describes an image compression system that allows great flexibility, not only for the compression of images but also for access into the codestream. The codestream provides a number of mechanisms for locating and extracting portions of the compressed image data for the purpose of retransmission, storage, display, or editing. This access allows storage and retrieval of compressed image data appropriate for a given application without decoding.

The purpose of this Recommendation | International Standard is to provide a network protocol that allows for the interactive and progressive transmission of JPEG 2000 coded data and files from a server to a client. This protocol allows a client to request only the portions of an image (by region, quality or resolution level) that are applicable to the client's needs. The protocol also allows the client to access metadata or other content from the file.

The substantive updates in this edition, compared to Edition 2, are:

1. specifies methods for HTTP/3 transported JPIP communication (Annex P); and
2. adds the H3 and H3S transport types to the definition of the New Channel request and response fields.

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INTERNATIONAL STANDARD
ITU-T RECOMMENDATION

Information technology — JPEG 2000 image coding system — Part 9: Interactivity tools, APIs and protocols

1 Scope

This Recommendation | International Standard[1] defines, in an extensible manner, syntaxes and methods for the remote interrogation and optional modification of JPEG 2000 codestreams and files in accordance with their definition in Rec. ITU-T T.800 | ISO/IEC 15444-1 and other members of the Rec. ITU-T T.8xx | ISO/IEC 15444-x family of Recommendations | Standards.

In this Recommendation | International Standard, the defined syntaxes and methods are referred to as the JPEG 2000 Interactive Protocol, "JPIP", and interactive applications using JPIP are referred to as "JPIP systems."

JPIP specifies a protocol consisting of a structured series of interactions between a client and a server by means of which image file metadata, structure and partial or whole image codestreams can be exchanged in a manner that avoids or minimises the communication of information not required by client. This Recommendation | International Standard includes definitions of the semantics and values to be exchanged, and suggests how these can be passed using a variety of existing network transports.

With JPIP, the following tasks can be accomplished in varying, compatible ways:

- the exchange of capabilities;
- the negotiation of capabilities to use in a session;
- the request and transfer of the following elements from a variety of containers, such as JPEG 2000 files, JPEG 2000 codestreams and other container files:
  - selective data segments;
  - selective and defined structures;
  - parts of an image or its related metadata.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- Recommendation ITU-T T.800 | ISO/IEC 15444-1, *Information technology – JPEG 2000 image coding system: Core coding system.*
- Recommendation ITU-T T.801 | ISO/IEC 15444-2, *Information technology – JPEG 2000 image coding system: Extensions.*
- Recommendation ITU-T T.802 | ISO/IEC 15444-3, *Information technology – JPEG 2000 image coding system: Motion JPEG 2000.*
- Recommendation ITU-T T.805 | ISO/IEC 15444-6, *Information technology – JPEG 2000 image coding system: Compound image file format.*
- Recommendation ITU-T T.809 | ISO/IEC 15444-10, *Information technology – JPEG 2000 image coding system: Extensions for three-dimensional data.*
- Recommendation ITU-T T.814 | ISO/IEC 15444-15, *Information technology – High-Throughput JPEG 2000.*
- Recommendation ITU-T T.815 | ISO/IEC 15444-16, *Information technology – Encapsulation of JPEG 2000 images into ISO/IEC 23008-12.*

[1] This Recommendation | International Standard contains an electronic attachment that is available from the ITU website at: https://handle.itu.int/11.1002/2000/7460, and from the ISO website at: https://standards.iso.org/iso-iec/15444/-9\ed-2/en.

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- IETF RFC 768 (1980), *User Datagram Protocol*. Available from World Wide Web: http://www.ietf.org/rfc/rfc0768.txt.
- IETF RFC 2046 (1996), *Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types*. Available from World Wide Web: http://www.ietf.org/rfc/rfc2046.txt.
- IETF RFC 2616 (1999), *Hypertext Transfer Protocol – HTTP/1.1*. Available from World Wide Web: http://www.ietf.org/rfc/rfc2616.txt.
- IETF RFC 3986 (2005), *Uniform Resource Identifiers (URI): Generic Syntax*. Available from World Wide Web: https://datatracker.ietf.org/doc/html/rfc3986.
- IETF RFC 5234 (2008), *Augmented BNF for Syntax Specifications: ABNF*. Available from World Wide Web: https://datatracker.ietf.org/doc/html/rfc5234.
- IETF RFC 9293 (2022), *Transmission Control Protocol*. Available from World Wide Web: https://datatracker.ietf.org/doc/html/rfc9293.
- IETF RFC 9000, *QUIC: A UDP-Based Multiplexed and Secure Transport*. Available from World Wide Web: <https://datatracker.ietf.org/doc/rfc9000>.
- IETF RFC 9001, *Using TLS to Secure QUIC*. Available from World Wide Web: <https://datatracker.ietf.org/doc/rfc9001>.
- IETF RFC 9114, *HTTP/3*. Available from World Wide Web: <https://datatracker.ietf.org/doc/rfc9114>.

3 Definitions

For the purposes of this Recommendation | International Standard, the terms and definitions given in Rec. ITU-T T.800 | ISO/IEC 15444-1 and Rec. ITU-T T.801 | ISO/IEC 15444-2 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at https://www.electropedia.org

3.1 Definitions from other standards or recommendations

The following definitions are used within this Recommendation | International Standard. In some cases, these definitions differ from those used in other standards and/or Recommendations.

3.1.1 **J2KI**: A file that conforms to the `'j2ki'` brand specified in Rec. ITU-T T.815 | ISO/IEC 15444-16.

3.1.2 **J2KS**: A file that conforms to the `'j2ks'` brand specified in Rec. ITU-T T.815 | ISO/IEC 15444-16.

3.1.3 **JPH**: The file format specified in Rec. ITU-T T.814 | ISO/IEC 15444-15: High Throughput JPEG 2000.

3.1.4 **JPEG 2000 codestream**: Codestream conforming to the specification in Rec. ITU-T. T.800 | ISO/IEC 15444-1, possibly including capabilities specified elsewhere.

3.1.5 **JPEG 2000 family file**: File conforming to one of the file formats defined in the Rec. ITU-T T.8xx | ISO/IEC 15444-x family of Recommendations | Standards.

3.1.6 **JPM**: The file format specified in Rec. ITU-T T.805 | ISO/IEC 15444-6.

3.1.7 **metadata**: Any collection of "boxes" from a JPEG 2000 family file.

3.1.8 **MJ2**: The file format specified in Rec. ITU-T T.802 | ISO/IEC 15444-3.

3.1.9 **connection**: Transport layer virtual circuit established between two programs for the purpose of communication.

Source: RFC 2616

3.1.10 **entity**: Information transferred as the payload of a request or response.

Source: RFC 2616

Note on entry: An entity consists of metainformation in the form of entity-header fields and content in the form of an entity-body.

3.1.11 **proxy**: Intermediary program which acts as both a server and a client for the purpose of making requests on behalf of other clients.

Source: RFC 2616

Note on entry: Requests are serviced internally or by passing them on, with possible translation, to other servers.

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3.1.12 **HTTP/1.1**: Hypertext Transfer Protocol specified in RFC 2616.

3.1.13 **HTTP/3**: Hypertext Transfer Protocol specified in RFC 9114.

3.2 JPIP definitions

The following definitions are used within this Recommendation | International Standard. In some cases, these definitions differ from those used in other standards and/or Recommendations.

3.2.1 **cache (client-side)**: Cache managed by the Client for storing JPIP data-bins.

Note on entry: The Client might have a limited cache and might have to purge cached JPIP data-bins from time to time.

3.2.2 **cacheable response**: Response that may be stored within a cache for use in answering subsequent requests.

Note on entry: Even if a resource is cacheable, there might be additional constraints on whether a cache can use the cached copy for a particular request.

3.2.3 **cache-model (server-side)**: Server-side estimation of the data-bins or portions of data-bins that are available in the client's cache.

Note on entry: The server can add items to its estimation of the client's cache because it assumes successfully delivery, or because it has received acknowledgements of transmitted data, or because of cache-model update statements.

3.2.4 **channel**: Mechanism for grouping requests and responses such that only one request/response is active at a time within the group.

Note on entry: Multiple channels can be used to issue multiple requests and receive multiple responses concurrently.

3.2.5 **client**: Program that establishes connections for the purpose of sending requests.

3.2.6 **codestream image region**: Intersection between the image and the region defined by the Offset and Region Size.

Note on entry: The codestream image region can be empty (no area).

3.2.7 **data-bin**: Set of bytes of the same type of data which can be partially delivered.

3.2.8 **incremental-codestream**: Representation of the codestream as a collection of data-bins (main header, tile header, precinct or tile data-bins) having the same codestream identifier.

3.2.9 **JPIP index table**: File format box which provides information about the location of portions of a file or codestream.

3.2.10 **JPEG 2000 family target**: Target that corresponds to a JPEG 2000 family file.

3.2.11 **logical target**: Specific representation of specific original named resource, or a byte range from that specific original named resource, to which the JPIP request is directed.

Note on entry: The specific representation might be transcoded from the original named resource.

3.2.12 **message**: Set of bytes from a single data-bin and the header identifying those bytes and the data-bin.

3.2.13 **raw codestream**: Representation of the codestream as a single metadata-bin.

3.2.14 **request**: Group of fields and values sent from the client to the server to obtain portions of an image or metadata.

3.2.15 **resource**: Network data object or service that can be identified by a URI.

3.2.16 **response**: Bytes sent from the server to the client after receiving a request.

3.2.17 **server**: Application program that accepts connections in order to service requests by sending back responses.

Note on entry: Any given program might be capable of being both a client and a server; 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.

3.2.18 **session**: Collection of requests and responses applying to the same resource for which the server maintains a cache model.

3.2.19 **session-based**: Where the server maintains a cache model.

3.2.20 **stateless**: Single request where the server does not make use of a cache-model in determining the response.

3.2.21 **target**: Logical identification of JPIP data.

Note 1 on entry: This is the name of the main target and is often the name of a file on the server.

Note 2 on entry: JPEG 2000 files or codestreams might be available in multiple representations (e.g., return type, precinct size) or vary in other ways, each identified by a unique logical target.

3.2.22 **tile header**: All tile-part headers for a specific tile.

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oz'	z-axis offset for suitable codestream region
ox"	Modified jpx x-axis offset for suitable region
oy"	Modified jpx y-axis offset for suitable region
oz"	Modified jpx z-axis offset for suitable region
r	Resolution level
s	A sequence number which identifies the precinct within its tile-component
sx	x-axis size of client request view-window
sy	y-axis size of client request view-window
sz	z-axis size of client request view-window
sx'	x-axis size for suitable codestream region
sy'	y-axis size for suitable codestream region
sz'	z-axis size for suitable codestream region
sx"	Modified jpx x-axis size for suitable region
sy"	Modified jpx y-axis size for suitable region
sz"	Modified jpx z-axis size for suitable region
t	An index (starting from 0) of the tile to which the precinct belongs
$\mathbf{W}_{\mathbf{cod}}$	The codestream width as recorded in the Image Header (ihdr) box (see Annex I.5.3.1 of Rec. ITU-T T.800 | ISO/IEC 15444-1)
$\mathbf{W}_{\mathbf{comp}}$	The width of the composited result, supplied in the JPX composition options box (see Annex M.11.10.1 of Rec. ITU-T T.801 | ISO/IEC 15444-2)
$\mathbf{W}_{\mathbf{reg}}$	The width of the compositing layer, as it appears on the compositing layer registration grid
$\mathbf{Ws}_{\mathbf{inst}}$	The cropped width
$\mathbf{Wt}_{\mathbf{inst}}$	The composited width
$\mathbf{XC}_{\mathbf{inst}}$	The x-axis cropping offset supplied via the relevant instruction (see Annex M.11.10.2.1 of Rec. ITU-T T.801 | ISO/IEC 15444-2)
$\mathbf{XO}_{\mathbf{inst}}$	The x-axis compositing offset, described via the relevant compositing instruction (see Annex M.11.10.2.1 of Rec. ITU-T T.801 | ISO/IEC 15444-2)
$\mathbf{XO}_{\mathbf{reg}}$	The x-axis codestream registration offset
XOsiz	The horizontal offset from the origin of the reference grid of the relevant codestream's SIZ marker segment
$\mathbf{XR}_{\mathbf{reg}}$	The x-axis codestream registration sampling factor, described at the beginning of any codestream registration box (see Annex M.11.7.7 of Rec. ITU-T T.801 | ISO/IEC 15444-2)
Xsiz	The width of the reference grid of the relevant codestream's SIZ marker segment
$\mathbf{XS}_{\mathbf{reg}}$	The x-axis registration precision described at the beginning of any codestream registration box (see Annex M.11.7.7 of Rec. ITU-T T.801 | ISO/IEC 15444-2)
$\mathbf{YC}_{\mathbf{inst}}$	The y-axis cropping offset supplied via the relevant instruction (see Annex M.11.10.2.1 of Rec. ITU-T T.801 | ISO/IEC 15444-2)
$\mathbf{YO}_{\mathbf{inst}}$	The y-axis compositing offset, described via the relevant compositing instruction (see Annex M.11.10.2.1 of Rec. ITU-T T.801 | ISO/IEC 15444-2)
$\mathbf{YO}_{\mathbf{reg}}$	The y-axis codestream registration offset

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YOsiz The vertical offset from the origin of the reference grid of the relevant codestream's SIZ marker segment

YR_{reg} The y-axis codestream registration sampling factor, described at the beginning of any codestream registration box (see Annex M.11.7.7 of Rec. ITU-T T.801 | ISO/IEC 15444-2)

Ysiz The height of the reference grid of the relevant codestream's SIZ marker segment

YS_{reg} The y-axis registration precision described at the beginning of any codestream registration box (see Annex M.11.7.7 of Rec. ITU-T T.801 | ISO/IEC 15444-2)

4 Abbreviations

For the purposes of this Recommendation | International Standard, the following abbreviations apply.

ABNF	Augmented Backus-Naur Form
DICOM	Digital Imaging and Communications in Medicine
DWT	Discrete Wavelet Transformation
EOR	End of Response
HTML	Hypertext Markup Language
IP	Internet Protocol
JPIP	JPEG 2000 Interactive Protocol
JPP	JPIP Precinct
JPT	JPIP Tile-part
MTF	Modulation Transfer Function
PDF	Portable Document Format
SVG	Scalable Vector Graphics
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UUID	Universal Unique Identifier
VBAS	Variable-length Byte Aligned Segment
XHTML	Extensible Hypertext Markup Language
XML	Extensible Markup Language

5 Conventions

5.1 ABNF rules

This Recommendation | International Standard uses the ABNF notation defined in RFC 5234, including the core ABNF syntax rules: ALPHA (letters), CR (carriage return), CRLF (Internet standard newline), CTL (control characters), DIGIT (decimal digits), HEXDIG (hexadecimal digits), LF (line feed), LWSP (linear white space) and SP (space). For the purposes of this Recommendation | International Standard, the following ABNF rules also apply.

```
NZDIGIT = %x31-39          ; 1-9
UPPER = %x41-5A            ; A-Z
LOWER = %x61-7A            ; a-z
UINT = 1*DIGIT
NONZERO = *"0" NZDIGIT *DIGIT
UINT-RANGE = UINT ["-" [UINT]]
UFLOAT = 1*DIGIT ["." 1*DIGIT]
OCTAL-ENCODED-CHAR = "\" QUADDIG OCTDIG OCTDIG
QUADDIG = "0" / "1" / "2" / "3"
OCTDIG = "0" / "1" / "2" / "3" / "4" / "5" / "6" / "7"
```


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