

# SMPTE REGISTERED DISCLOSURE DOCUMENT



## SMPTE Timecode Extensions – Relationships to Higher Rates and Date-Time

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## Introduction

This clause is entirely informative and does not form an integral part of this Registered Disclosure Document.

### Legacy wired infrastructure transition to IP network

The transition from SDI to IP network-based ecosystems combined with integer, fractional and higher media-rates presents a requirement for media labeling with a precise, symmetric mathematical relationship to clock time. The reference clock time is subject to local adjustments for time zones, seasonal daylight saving time shifts and leap second corrections.

Centralized master reference sync generators with a wired distribution tree are to be supplanted or replaced by a global clock time distribution and local reference signal generation. These master generators can synchronously generate signals for multiple audio and video media-rates. SMPTE timecodes have commonly been used as the clock time reference within a facility and they will need to interoperate with global clock time sources. Fractional media-rates present a particular problem since their representation of time shifts throughout a calendar day and the alignment to midnight or any other time point changes. Maintaining synchronization and timing precision across multiple references requires the ability to precisely and symmetrically convert timecodes at different rates to and from clock time,

### Synchronization in an IP network based on clock time

PTP is typically the most convenient and appropriate method for the transport of clock time within most production environments, however events that occur over dispersed and remote locations, (e.g. sporting events such as skiing, golf, car racing and sailing) might require other means of acquiring accurate date and clock time.

The typical workplace for both equipment and people operates with a perceived relationship to local calendar date and clock time.

With a 43 plus year history, SMPTE timecode equipment, applications, and peta bytes in media archives there is a requirement to maintain support for the standard. Established working practices and interoperability with media at different rates, in particular those involving fractional rates, requires the symmetric conversion between media timecode labels at different rates.

The current SMPTE ST 12-1 is nominally constrained to the video frame rates of 24, 25, 30, 24/1.001 and 30/1.001 Hz. Video at twice these rates can be accommodated for progressive video formats. Higher media-rates such as 100, 120 and 120/1.001 Hz are already standardized and higher integer multiples are anticipated in the future. This RDD specifies an extension to the SMPTE timecode to accommodate integer multiples of the legacy rates in a manner similar to SMPTE ST 12-3 but without deprecating the flag bit functions.

The binary groups with a standard multiplex protocol as defined in SMPTE ST 262 enables the higher rate labeling and encoding of date, rate, leap second, time zone UTC offset and other metadata.

### Integer and fractional rate media signals

With media signals aligned relative to the SMPTE epoch media signals that are at integer rates will be aligned at midnight of each day and furthermore to each integer second. As a result the length-of-day in media units

will be an integer number of media units in a 24-hour day, whether this is or is not a leap second introduction day. It is noted that although 25 Hz PAL video signals are at an integer media-rate, when the color field sequence is taken into consideration the color frame block has a non-integer 6.25 Hz rate.

For media signals that are at fractional rates, such as 30/1.001 Hz, these signals will only rarely be aligned at midnight or even at integer seconds. These fractional rates result in a nominal 24-hour day where the alignment of the media units have a varying alignment to midnight on a day-to-day basis and the length-of-day in media units will be an alternating integer number of media units starting in successive day periods.

### Integer count media label

This RDD sets out procedures to label media units with a zero-based integer media count that has a symmetric relationship to a calendar date and time. This process takes into consideration timescale shifts such as time zone UTC offsets, leap second introductions, and daylight saving time shifts.

For media that has been aligned relative to the SMPTE epoch as specified in SMPTE ST 2059-1 there is a defined mathematical relationship between the media timescales and the clock timescales. This is true for integer media-rates and although the relationship is slightly more complex this is also true for the fractional ( $n/1.001$ ) media-rates. This alignment to the SMPTE epoch enables SMPTE timecodes to be generated with a symmetric, mathematically precise correspondence.

Since the precise time point of the first media unit is known the precise time of any media unit within the day can be calculated and the reverse calculation to date and clock time can also be precisely calculated from the date and media-index values.

### Timecode extensions

Legacy systems define a correlation between the video signal's color sequence and time address values. Thus there is the concept of a two unit media block for analog NTSC video or a four unit media block for analog PAL video. For 30/1.001 Hz timecode with drop frame time address labelling the drop frame algorithm makes corrections to the time address in increments of two media unit counts. To minimize anomalies in converting between the new media-index label and legacy timecode time address values it is desirable to maintain blocks of two media unit counts when labeling video media in these systems. The legacy term "color frame" now more correctly relates to the concept of an alignment in "even/odd frame" media unit pairs.

### Summary

1. There is no change to the standard SMPTE ST 12-1 time address other than allowing the last minute of the day to count beyond 59 seconds to 60 or 61 in order to accommodate the short-day and long-day UCC counts and the incorporation of a leap second. This change from conventional implementations is already envisaged in SMPTE ST 12-1 Annex A.2.
2. There are no changes to the functions of the six flag bits of the SMPTE ST 12-1 timecode.
3. Additional data and metadata can be coded in the binary groups using SMPTE ST 262 Page-Line protocol.
4. Optionally SMPTE ST 309 can be used to code the date, UTC offset and DST for compatibility with existing applications. This will code some of the additional data and metadata but will not provide all of the new features.
5. New extended features

- The existing 24, 24/1.001, 25, 30, and 30/1.001 count rates are extended to include integer multiples up to 32 times the existing rates. This is similar to SMPTE ST 12-3 but without deprecating the functions of the ST 12-1 flag bits.
- The binary groups can code the following:
  - The media unit (frame) count rate.
  - The UTC compensated count (UCC) mode status.
  - The local time UTC offset.
  - The heritage flag that can signal an original timecode label that should not be modified in the production process.
  - The local time DST shift.
  - The date is a day-number expressed as a zero based count from the calendar day 1972-01-01.
  - Three binary group multiplex structures can code the additional data and metadata.
  - Critical fast changing data is coded in each multiplex so that it is there on every frame.
  - Day-number, UTC offset and DST are generally static and share multiplex over sequential frames.
  - Seven bits in the second multiplex enable a user defined binding to an external device or process.
  - Sixteen bits in a third multiplex can be used for user defined metadata.

The end result is a compatible extension of SMPTE ST 12-1 LTC or VITC and ST 12-2 ATC that have a symmetric, mathematically precise relationship to a precision clock time source and that supports extended count rates up to 960 frames per second.

Legacy equipment, applications and standards can transport and store the enhanced timecode without the requirement for modifications. Naturally they will need updating to utilize new capabilities but this is only required at the end points.

## **1 Scope**

This RDD is for media at the integer or fractional base-rates of 24, 24/1.001, 25, 30, 30/1.001 Hz and their integer multiples. This RDD describes a UTC Compensated Count (UCC) algorithm that defines the generation of media counts with a symmetric and mathematically precise relationship to the local calendar date and time. From the calendar date and UTC offset this UCC algorithm, determines the phase offset from midnight to the start of the first media block of the timecode day and the media counts throughout the day. The media count converted to a SMPTE ST 12-1 time address inherits the precision relationship to the local time-of-day and also to media at other rates. For rates at integer multiples of the base-rates the time address frame count extensions can be coded in the binary groups along with date, UTC offset, DTAI, user data and other operational metadata. The extra media counts for 30 Hz related fractional rates that exceed the normal 24 hour time address labels and labels for leap seconds can be coded in extended labels at the end-of-day. The RDD supports coding of data into the binary groups using the SMPTE ST 262 page-line multiplex or optionally the SMPTE ST 309 protocols.

## **2 Conformance Notation**

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any clause explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword "reserved" indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword "forbidden" indicates "reserved" and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; s shall be next; then formal languages; then figures; and then any other language forms.

### 3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this RDD. At the time-of-publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this RDD are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE ST 12-1:2014, Time and Control Code

SMPTE ST 262:1995, Binary Groups of Time and Control Codes – Storage and Transmission of Data

SMPTE ST 309:2012, Transmission of Date and Time Zone Information in Binary Groups of Time and Control Code

SMPTE ST 318:2015, Synchronization of 59.94- or 50-Hz Related Video and Audio Systems in Analog and Digital Areas — Reference Signals

SMPTE ST 2059-1:2015, Generation and Alignment of Interface Signals to the SMPTE epoch

SMPTE ST 2059-2:2015, SMPTE Profile for Use of IE-1588-2008 Precision Time Protocol in Professional Broadcast Applications

Audio Engineering Society (AES) AES67:2018, AES standard for audio applications of networks - High-performance streaming audio-over-IP interoperability

Institute of Electrical and Electronics Engineers (IEEE) IEEE 1588-2008, Precision Clock Synchronization Protocol for Networked Measurement and Control Systems

Internet Engineering Task Force (IETF) RFC 5905 Network Time Protocol Version 4: Protocol and Algorithms Specification, June 2010, Available: <https://tools.ietf.org/html/rfc5905>

## **4 Terms and Definitions**

For the purposes of this document, the following terms and definitions apply.

### **4.1 Acronyms and symbols**

The following acronyms and their definitions apply.

- 4.1.1 § clause
- 4.1.2 BCD binary coded decimal
- 4.1.3 GNSS Global Navigation Satellite Systems
  - 4.1.3.1 GPS Global Positioning System (US)
  - 4.1.3.2 Galileo (European Union)
  - 4.1.3.3 GLONASS (Russia)
  - 4.1.3.4 BeiDou (China)
  - 4.1.3.5 IRNSS (India)
- 4.1.4 LoD length-of-day
  - 4.1.4.1 LoDmu length-of-day in media units
  - 4.1.4.2 LoDss length-of-day in seconds
- 4.1.5 NTP Network time protocol
- 4.1.6 PTP Precision time protocol
- 4.1.7 SoD midnight start-of-day
  - 4.1.7.1 SoDss timecode start-of-day offset in seconds
  - 4.1.7.2 SoDmu timecode start-of-day offset in media units
- 4.1.8 TAI International Atomic Time
- 4.1.9 ToD time-of-day
  - 4.1.9.1 ToDss time-of-day in seconds
- 4.1.10 UCC UTC compensated count
- 4.1.11 UTC Universal Coordinated Time
- 4.1.12 VANC vertical ancillary
- 4.2 Mathematical functions

The following mathematical functions and their definitions apply.

**4.2.1**

**absolute value function;**

**ABS(x)**

arithmetic operation that returns the absolute value of the parameter 'x'

**4.2.2**

**less than;**

**a < b**

logical comparison operation that returns 'True' if the value of the parameter 'a' is less than the value of parameter 'b' and otherwise returns 'False'

**4.2.3**

**greater than;**

**a > b**

logical comparison operation that returns 'True' if the value of the parameter 'a' is greater than the value of parameter 'b' and otherwise returns 'False'

**4.2.4**

**greater than or equal to;**

**a ≥ b**

logical comparison operation that returns 'True' if the value of the parameter 'a' is greater than or equal to the value of parameter 'b' and otherwise returns 'False'

**4.2.5**

**less than or equal to;**

**a ≤ b**

logical comparison operation that returns 'True' if the value of the parameter 'a' is less than or equal to the value of parameter 'b' and otherwise returns 'False'

**4.2.6**

**assignment;**

**a = b**

mathematical or logical operation that's assigns the value of parameter 'b' to the parameter 'a'

**4.2.7**

**equal to (comparative);**

**a == b**

logical comparison operation that returns 'True' if the value of the parameter 'a' is equal to the value of parameter 'b' and otherwise returns 'False'

**4.2.8****modulus operator;****a % b;****MOD(a, b)**

mathematical operation that divides the operand 'a' by the operand 'b' and returns the remainder

The mathematical operation is equivalent to the following formulae:

$$MOD(a,b) = a \% b = a - b \times FLOOR(a / b)$$

**4.2.9****ceiling function;****least integer function;****CEIL(x)**

step function of 'x' which is the least integer greater than or equal to 'x'

The mathematical operation that rounds the element 'x' to the nearest integer towards positive infinity

**4.2.10****floor function;****greatest integer function;****FLOOR(x)**

step function of 'x' which is the greatest integer less than or equal to 'x'

The mathematical operation that rounds the element 'x' to the nearest integer towards negative infinity

**4.2.11****round function;****ROUND(x)**

step function of 'x' that rounds the element 'x' to the nearest integer

Since the definition is ambiguous for half-integers, the additional rule that half-integers are always rounded to even numbers is usually added in order to avoid statistical biasing.

Note to entry: The round function is also called NINT or the nearest integer function.

**4.2.12 SIGN(x)**

mathematical function that returns "one" when the element 'x' is zero or a positive number and returns "minus one"

Note to entry: Since some implementations of this function might return different results if the element 'x' is zero.

## **4.3 General terms and definitions**

### **4.3.1**

#### **Boolean**

binary variable, having two possible values called “True” and “False”

When converting other value types to Boolean; values that equate to zero, null, void or empty are considered to equate to ‘False’ and all other values are considered to equate to ‘True’.

#### **4.3.1.1**

##### **False**

Boolean truth value representing a negated or not valid condition

#### **4.3.1.2**

##### **True**

Boolean truth value representing a valid condition

### **4.3.2**

#### **calendar day**

day in the Gregorian calendar for the applicable local time zone

### **4.3.3**

#### **DST**

##### **daylight saving time**

shift of the standard time in some regions of the world during the warmer months of the year to give more daylight hours in the evening

The local time zone offset is advanced by one hour or in some cases an offset in quarter hour increments. The dates for the onset and end of the daylight saving period are determined by the local legal authorities and this information should be supplied by the application.

Note: The DST offset is typically one hour, however in a few regions of the world a different DST offset bias such as 15 or 30 minutes is employed. Historically other DST offsets have been used, for example a DST offset of two hours was used in the UK during WWII.

### **4.3.4**

#### **day-number**

zero based count of calendar days from the day-zero

#### 4.3.4.1 day-zero

calendar day 1972-01-01, local time UTC offset as adopted for use by the application

#### 4.3.5 DTAI

value of the leap second offset as the difference between TAI and UTC

*DTAI = TAI – UTC can be regarded as a correction to be added to UTC to obtain TAI.*

SOURCE: ITU-R TF.460-6

#### 4.3.6 Julian Day Number JD

integer day count assigned to a whole solar day starting from noon Universal time (UT)

The JD zero is assigned to the day starting at noon on Monday, January 1, 4713 BC, proleptic Julian calendar (November 24, 4714 BC, in the proleptic Gregorian calendar). The Julian date (JD) of any instant is the Julian day number plus the fraction of a day since the preceding noon in Universal Time.

#### 4.3.7 media unit

video frame

#### 4.3.8 media block

even-odd numbered pair of media units for 24, 24/1.001, 30 and 30/1.001 Hz related media or four media units for 25 Hz analog media with a defined color frame sequence

#### 4.3.9 media-index

zero based count of media units from a defined origin

#### 4.3.10 midnight end-of-day midnight start-of-day midnight

transition time from one day to the next and the moment when the date changes.

#### **4.3.11**

##### **Modified Julian Day**

##### **MJD**

integer day count assigned to a whole lunar day starting from midnight to midnight

The MJD value equals the JD less 2 400 000.5 and therefore has its origin, in the case of UT, at 0000 hours UT, 17 November 1858 and represent Gregorian calendar days.

#### **4.3.12**

##### **phase-index**

measure of media phase alignment relative to a seconds' time point

The phase-index for fractional-1001 media is in discrete integer steps with a nominal range from zero to 1000.

#### **4.3.13**

##### **resolution, precision and accuracy**

trio of terms that relate to how closely an objective can be met

##### **4.3.13.1**

##### **resolution**

fineness or smallest unit of measure or change that can be displayed or recorded

Resolution sometimes referred to as granularity.

One way that the resolution and precision are always related is that resolution determines the upper limit of precision. The precision cannot exceed resolution.

##### **4.3.13.2**

##### **precision**

fineness to which a measurement can be made repeatedly and reliably

Precision is a measure of variability. Precision indicates how reproducible or close identical measurements will be reported as a percentage of full scale.

##### **4.3.13.3**

##### **accuracy**

measure of "trueness"

Accuracy is the ability to measure the designated parameter to the absolute true and correct value. Accuracy is analogous to the amount of uncertainty in a measurement.

**4.3.14****SMPTE timecode**

generic reference to SMPTE Time and Control Codes as defined in SMPTE ST 12-1, ST 12-2 or ST 12-3

**4.3.15****time zone**

geographical region of the earth that selects an offset from UTC as the basis for local time keeping

Note to entry: Some time zones might apply a DST offset to the Standard time (STD) UTC offset for part of the year.

**4.3.16****time point**

mark attributed to an instant by means of a specified timescale

**4.3.17****time instant;  
instant**

time point on the time axis.

**4.3.18****timecode day**

timecode associated with the values from 00:00:00:00 up until the roll-over to 00:00:00:00 of the next day

For a calendar day and media at integer rates the timecode day can be associated with a calendar however for media at fractional rates the start and end of the timecode day are expected to be shifted slightly and this shift will change from day-to-day and with the UTC offset.

**4.3.19****timing reference point;  
timing reference datum**

reference location in the signal used to specify the timing of the signal

Note to entry: SMPTE ST 12-1 uses the term timing reference datum to specify this location as the half-amplitude point of the first transition of bit 0 of the 80-bit LTC codeword.

## 5 Executive summary (informative)

### 5.1 General

For media that has been aligned relative to the SMPTE epoch as specified in SMPTE ST 2059-1 there is a precise mathematical relationship between the media timescales and the TAI or UTC timescales. This enables SMPTE timecodes to be generated with a symmetric, mathematically precise correspondence to clock time.

This RDD uses date, time and related metadata from a clock time source or the user application to manage the creation of a SMPTE timecode and the coding of sufficient metadata to recover the date and time. The process of creating the timecode involves four basic steps:

1. Conversion of the reference date, time and related metadata to the form of a day-number and count of seconds from midnight is specified in Annex A through Annex E. The timestamp reference might be in the form of a calendar date and time-of-day or in the form of a seconds count such as a PTP timestamp.
2. Generation of a media-index as an integer count of media units from the day-number, time-of-day and related metadata is specified in § 6.
3. Formatting the media-index, day-number and metadata to data elements suitable for mapping into a timecode time address and binary groups is specified in § 6.
4. Mapping the time data elements into a SMPTE ST 12-1 timecode time address is specified in § 7 through § 9. Mapping of other data and metadata elements into the SMPTE ST 12-1 timecode binary groups is specified in § 8 and § 9.

Additional topics related to handling SMPTE timecodes and applications are covered in § 10 and § 11.

### 5.2 Date and time sources

The source of accurate date, time and related metadata can be PTP, GPS, NTP or the application itself. A LTC, VITC or ATC source that was generated according to this RDD could also be used. The generation of a precise timecode from date and clock time depends on the application in consort with date, time and related metadata sources to derive the following data elements:

- Day-number as a zero based integer count of days from the local calendar day 1972-01-01.
- Local time-of-day, formatted as a zero based count of seconds from the local time midnight.
- Local time offset from UTC, as a signed value in hours and minutes in 15-minute increments.
- Time-of-day count origin, as the timecode start-of-day, or optionally as user defined.
- Media-rate, formatted as a base-rate (24, 25, or 30 Hz), a scale factor (1/1 or 1/1.001), and an integer rate-multiplier (selected multipliers in the range from: one to 32).
- DTAI, as an integer value of the leap second offset for the calendar day.
- Media format, as progressive video, interlaced video first field, interlaced video second field, or undefined.
- Status flags: (True/False)
  - Date and clock time is derived from an accurate source.
  - Media is time aligned relative to the SMPTE epoch.

- Local daylight saving time (DST) is in effect.
- A leap second incorporation is scheduled for the current calendar day.
- The current second is a leap second.
- Timecode is an original or heritage timecode intended to be preserved through the production process.

The generation of precise timecodes is based on the presumption that the media is generated in alignment relative to the SMPTE epoch as defined by SMPTE ST 2059-1 and the accurate time clock reference is consistent with this alignment. The process uses the calendar day 1972-01-01 as an origin for a day-number count.

The process of media count generation can be referenced to different sources of calendar date and clock time as specified in § 6 and Annex A through Annex E.

### 5.3 Media-index and metadata generation

Media essences at integer media-rates have integer numbers of media units in a 24-hour calendar day. For media aligned to the SMPTE epoch time point according to SMPTE ST 2059-1, the first media block of the day will be aligned at midnight and also a media unit will be aligned to each second throughout the day.

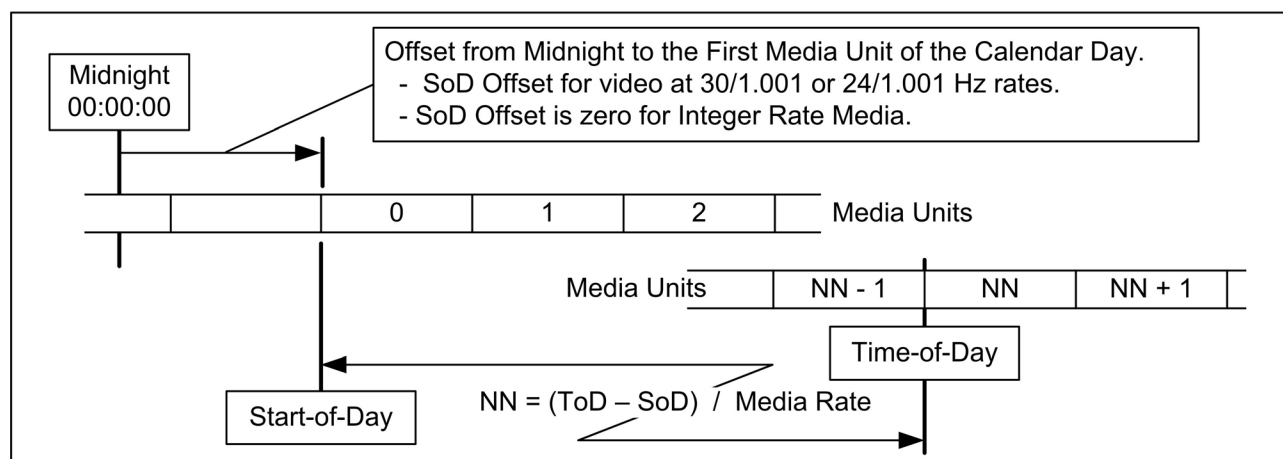


Figure 1 – Alignment offset from midnight to first media block

Media essence at fractional media-rates does not have an integer number of media units in a 24-hour day. For media aligned to the SMPTE epoch time point according to SMPTE ST 2059-1, the phase alignment of the calendar day midnight to the first media block has an offset at the start of each calendar day. This phase alignment offset varies from day-to-day and also with the local time UTC offset. The midnight to first media block phase alignment offset is shown in Figure 1 above. The phase alignments are in discrete steps labeled with integer phase-index numbers, which have a nominal range from zero to 1000.

The resulting media-index can have a symmetric, mathematically precise relationship to date and clock time.

Note: The media-index is formally defined as a zero-based count of media units in § 6.4.

## **5.4 Date, time and metadata formatting**

The integer day-number and media-index counts are formatted as discrete YYYY. MM, DD, hh, mm, ss, ff, ee date-time elements plus related metadata and flags as specified in § 7.2.

The discrete date-time elements as a compound element representation of the integer media-index maintains the precise mathematical relationship to clock time.

## **5.5 Mapping into SMPTE timecodes**

The date and time elements and related metadata are mapped into the time address of SMPTE timecodes is specified in § 7. The date, extended frame counts, media-rate, time zone UTC offsets plus flags for DST, SMPTE epoch alignment, UCC count, accurate date-time clock reference and heritage status can be multiplexed into the binary groups according to SMPTE ST 262 as detailed in § 8.

The resulting SMPTE timecodes have a symmetric, mathematically precise relationship to clock time and the binary groups include sufficient data to support a precise conversion to local calendar date and clock time.

Alternately the date, time zone UTC offsets and DST flag can be mapped into the binary groups according to SMPTE ST 309 as detailed in § 9.

## 6 Generation of a media-index related to a calendar day

### 6.1 Date and time data sources

The principal data source is the clock timestamp, which is used to align and set the media-index counter. The clock timestamp represents a time point that can be presented in different measures of date and clock time.

There are many methods of acquiring a clock timestamp including a wired network such as the Ethernet, a GNSS receiver, a timecode, or a radio broadcast. Some of these methods are:

- IEEE 1588-2008 Precision time protocol (PTP) as specified in Annex A.
- Global navigation satellite systems (GNSS) as specified in Annex B.
- NTPv4 Network Time Protocol as specified in § Annex C.
- SMPTE ST 12-x suite of timecodes as specified in Annex D.
- Generic date and time-of-day as specified in Annex E.

The timestamp is expressed as a day-number, a UTC offset and a time-of-day according to the time source used and as detailed in Annex A through Annex E and detailed in Table 1. The application that uses this RDD shall be responsible for providing any data or metadata that is not available from the clock timestamp sources.

**Table 1 – Data parameters from date-time and metadata sources**

| Parameter                                                                                                                           | Remarks                       | Date and time sources |                |                |                     |                   |
|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-----------------------|----------------|----------------|---------------------|-------------------|
|                                                                                                                                     |                               | PTP<br>Annex A        | GPS<br>Annex B | NTP<br>Annex C | Timecode<br>Annex D | YMDhms<br>Annex E |
| Day-number**                                                                                                                        | Count of days                 | § A.5                 | § B.3          | § C.3          | § D.4               | § E.4, § E.5      |
| Time-of-day **                                                                                                                      | Count of seconds<br>(ToDss)   | § A.4                 | § B.4          | § C.4          | § D.5               | § E.6             |
| Time metadata                                                                                                                       | UTC offset (±hh:mm)           | § A.2                 |                |                | § D.3               | § E.3             |
|                                                                                                                                     | Daylight saving flag<br>(DST) | § A.2                 |                |                | § D.1               | § E.1             |
|                                                                                                                                     | DTAI                          | § A.2                 | § B.1.1        |                | § D.1               | § E.1             |
| ** Note: The timestamp data source might report the day-number and time-of-day related to UTC or an UTC offset local date and time. |                               |                       |                |                |                     |                   |

### 6.2 Day-number, time-of-day and related metadata timestamp parameters

To calculate a media-index related to local time this RDD uses the date-time data as a day-number and the local time-of-day, *local time* UTC offset, DTAI and media-rate.

The date, time, related metadata and other data gathered from the various date and time sources is summarized in the following clauses. The data and metadata not provided by these sources needs to be provided by the application. The count origin is specified in § 6.6 and the count rate is specified in § 6.7.

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Based on the date and clock time source as specified in § 6.1, the media-index is determined as specified in § 6.8 through § 6.11.

Note: When the time-of-day (ToDss) is a value before the start-of-day in seconds (SoDss) as determined in § 6.11 this indicates that this is a time in the prior day-number, The day-number might need decrementing and the calculations repeated.

Calendar dates shall be based on the Gregorian calendar. The day-number shall be the zero-based number of days since the day-zero time point, 1972-01-01T00:00:00±hh:mm (UTC) on the local UTC offset timescale. The day-number is used to calculate the number of media unit counts in the day, LoDmu, as detailed in § 6.8.1 or § 6.10.1 and the timecode start-of-day alignment phase-index offset for a UTC time midnight as detailed in § 6.10.2.

The clock time-of-day, which can be input in any combination of hours, minutes, seconds and sub-seconds . The *local time*, UTC offset is a value in signed hours and minutes.

Since leap second introductions do not follow a regular pattern the DTAI value could be input from the date and clock time source or determined based on the date in conjunction with a look-up such as Table 12 in Annex F, § F.2.

### **6.3 Calendar day length**

The calendar day length for a common day is 86400 seconds, for a positive leap second day is 86401 seconds, and for a negative leap second day is 86399 seconds,

For each leap second, the Annex F, Table 12 “DTAI history” lists the day-numbers of the days that begin a period with a changed DTAI value. These are the days that begin just after the incorporation of a leap second. The day-number should be tested with the procedure IsLeapSecondDay(day-number) as specified in Annex H, § H.1.5 to determine if a leap second is incorporated at the end of a day-number and thus determine the length in seconds for the calendar day.

### **6.4 Media-index count**

The media-index shall be a zero-based count of media units (for example video frames). For media at integer rates the timecode start-of-day origin can be at midnight, however for media at fractional rates the timecode start-of-day origin will vary from day-to-day and although close to midnight will rarely be precisely at midnight. User applications that simply need a label to facilitate referencing media positions without a symmetric, mathematically precise relationship to precision clock time may choose a user designated count origin.

### **6.5 UTC compensated count (UCC)**

This RDD defines a UCC media-index that has a symmetric, mathematically precise relationship to clock time.

For a UCC the media shall have been generated with an alignment relative to the SMPTE epoch. For media at integer rates the media will be aligned to each second time point. For media at the fractional rates the media aligned at the SMPTE epoch time point is aligned every 1001 seconds after that. The alignment

relative to the other 1000 seconds follows a defined sequence of offsets returning to in alignment on second 1001.

For media at integer rates there is a constant media-index count range for each calendar day UTC offset. For media at fractional rates the count range follows a defined sequence of short-days and long-days over a nominal period of 1001 days. On days when a leap second is incorporated the count range sequence is adjusted accordingly.

The UCC algorithms determine the media alignment relative to midnight based on the day-number, UTC offset, DTAI, and the media-rate. The media-index can be calculated for any time point within the day.

## 6.6 Media-index count origin

The media-index count origin should be related to the calendar day midnight origin, however a different user designated origin may be defined. For a user designated origin the procedures may be used but the results might not have a defined relationship to clock time.

## 6.7 Media-rates

The media-index typically has a one-to-one relationship to the media units however the application may generate media-index and timecodes at other rates. This RDD supports rates based on the SMPTE ST 12-1 count rates of 24, 25, and 30 frames per second. The media-rate is expressed by the base-rate as defined in § 8.4, the rate-scale-factor as defined in § 8.5 and the rate-multiplier as defined in § 8.6.

While the media-index is an integer count the media may be at an integer rate or a fractional rate. The media count should reflect the actual rate of the media.

Note: In a family of media-rates where members in the family are at integer multiples of the base-rate, some higher rates can also be a member of more than one family each with a different base-rate and rate-multiplier. For example media at a 120/1.001 Hz rate can be a four times multiple of 30/1.001 Hz or a five times multiple of 24/1.001 Hz.

## 6.8 Integer rate video media-index

Media at integer media-rates have an integer number of media units in a 24-hour calendar day and for media aligned to the SMPTE epoch according to SMPTE ST 2059-1 the first media block of the day will be aligned relative to midnight and also video frames will be aligned to each second throughout the day. Thus the alignment phase-index shall be equal to zero for integer rate video.

Note: For color framed 25 Hz analog video the media block rate is 6.25 Hz and thus the media blocks will only be aligned every four seconds and aligned to a midnight every four days.

### **6.8.1 Length-of-day in media units (LoDmu)**

The media-index length-of-day in media units for integer media-rates shall be a constant value for common days and changes for days with the incorporation of a leap second.

$$LoDmu = day-length \times media-rate$$

Where: *day-length* is the length-of-day in seconds as specified in § 6.8.1.

*media-rate* is the value in Hz (integer values), as specified in § 6.7.

### **6.9 Fractional rate video media-index**

Video media at fractional media-rates does not have an integer number of media units in a 24-hour day. The phase alignment of the first media block to the calendar day midnight varies from day-to-day, the local time UTC offset and DTAI. These phase offsets are in quantum steps designated by a phase-index number.

The media-index value is calculated based on the day-number, the local time UTC offset, the time-of-day and the media-rate. The method accommodates leap second incorporations to the clock timescale.

### **6.10 Daylight saving time offset**

In this RDD the daylight saving shift applies a different UTC offset timescale to the calculation of the media-index. For example in an Eastern US time zone the standard time UTC offset is “-05:00”, however when daylight saving (DST) is in effect the UTC offset is “-04:00”.

$$UTC\ offset(DST) = UTC\ offset\ (STD) + DST\ offset$$

The result is that media labels expressed in a clock time format shall shift by exactly the magnitude of the DST offset shift.

#### **6.10.1 Length-of-day in media units (LoDmu)**

For media at the fractional rates, the day shall be designated as a short-day or a long-day and a corresponding number of media unit counts in the day.

The procedure in § 6.10.1.1 calculates the length-of-day in media units (LoDmu), and the long-day / short-day designation. These calculations shall determine the LoDmu for media at the base-rate and for rates that are an integer multiple of the base-rate the LoDmu values shall be multiplied by that multiple.

Note: It is important that these calculations use the base-rate so that at the higher media-rates, the media-index zero start is at the same time instant for all rate family members.