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Systems

INFORMATION TECHNOLOGY -

GENERIC CODING OF MOVING PICTURES AND ASSOCIATED AUDIO:
Real-Time Interface Specification for Low Jitter Applications

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ISO/IEC 13818-9
Recommendation H.222.x

Committee Draft

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1. Introduction

Conformance for ITU-T Rec H.222.0 | ISO/IEC 13818-1 Transport Streams is specified in terms of the normative specifications in part 1 of this Recommendation | International Standard. These specifications include, among other requirements, a Transport Stream System Target Decoder (T-STD) which specifies the behavior of an idealized decoder when the stream is input to such a decoder. The T-STD model, and the associated verification, do not include information concerning the stream in real time.

This part of the standard specifies the timing of the real-time delivery of the bytes of Transport Stream packets at a Real Time Interface for Low Jitter applications (RTI-LJ). This specification does not change or supersede any of the requirements in Part 1 of this Recommendation|International Standard. All Transport Streams, whether or not they are delivered in accordance with the RTI, shall comply with the T-STD model. In particular, the accuracy requirement in Part 1 for PCRs in Transport Streams is not changed by the requirements of this section. Compliance with part 9 of the Recommendation|International Standard is optional.

Equipment which includes some type of interface for Transport Stream data, the timing characteristics of which are said to comply with the RTI-LJ specification, must be able to operate normally with any input which complies with the RTI-LJ specification. In no case, however, is a piece of equipment required to implement an RTI-LJ interface.

Figure 1-0 provides a simplified view of the scope of ISO/IEC 13818-9. This figure shows a Data Link Interface Adaptor , a Real-Time Interface Decoder (RTD), and the location of the Transport stream which complies with the RTI Specification. It should be noted that the Data Link Interface Adaptor is responsible for removing any data link protocol/data structures, as well as any timing variations (i.e.) in order to produce a compliant RTI Transport Stream. This RTI Specification has been developed specifically for applications in which the input to the Data Link Interface Adaptor contains a moderate amount of jitter. If the data link has high jitter characteristics, such as may be found in some ATM and LAN applications, then the design of a simple, low cost Data Link Interface Adaptor may not be feasible.

- insert figure 1-10 here

2. Real-Time Interface Requirements for Low Jitter Applications

2.1 The Real-Time Interface Decoder Model for Low Jitter Applications

The Real-Time Interface Decoder Model for Low Jitter applications, called the RTD-LJ, is a conceptual model used to define the RTI-LJ normative requirements. The RTD-LJ is used only for this purpose. Neither its architecture nor the timing described precludes uninterrupted, synchronized playback by a variety of decoders with different architectures or timing schedules.

The RTD-LJ is exactly the same as the T-STD model defined in part one of this Recommendation|International Standard, except that

- the byte delivery schedule defined in the T-STD is replaced by the actual byte arrival time in the RTD-LJ;
- real-time constraints are imposed on the values of PCR in relation to their arrival time in the RTD-LJ;
- the buffer sizes defined in the T-STD are different in the RTD-LJ; and
- an extra requirement on the Transport Buffer occupancy, see below.

2.2 Clock Frequency Requirements

The requirements on the System time clock w.r.t. frequency and frequency slew given in part one of this Recommendation | International Standard are also mandatory for the Real-Time Interface for Low Jitter applications..

2.3 PCR Accuracy Requirements

This section defines a single constraint on the relationship of the arrival time of all the bytes containing the last bit of a program_clock_reference_base field for a single program of a Transport Stream, and the value carried in the corresponding program clock reference.

Specifically,

- let system_clock_counter be a counter that counts cycles of a system clock that satisfies the frequency requirements specified in clause 2.2 above, where t represents time;
- let i'' be the index of a byte containing the last bit of a program_clock_reference_base field;
- let t(i'') be the time at which byte i'' arrives in the RTD_LJ; and
- let PCR(i'') be the value of the program clock reference associated with byte i'';

then there shall exist such a system_clock_counter(t) and a sequence of times e(i'') that satisfy

$$PCR(i'') = system\_clock\_counter((t(i'') + e(i''))\%(300*2^{33})$$

and

$$- t\_jitter <= e(i'') <= t\_jitter.$$

2.4 Buffer Requirements

The buffers in the RTD-LJ have the same names as those in the T-STD, indexed with an r. Their sizes are:

TBS_rn = TBSn + (2*t_jitter*Rx) + 188 bytes
TBS_rsys = TBSsys + (2*t_jitter* Rx) + 188 bytes
sb_size(r) = sb_size + (2*t_jitter*sb_leak_rate) + 188

It should be noted that the use of the smoothing buffer (sb) is optional for the RTD-LJ, as it is in ISO/IEC 13818-4.

The multiplex buffer (for video) and the decoder buffer (for audio and systems data) in the RTD-LJ have the sizes:

MBS_nr = MBS_n + (4* t_jitter * Rx),
BS_nr = MBS_n + (4* t_jitter * Rx), and
BS_rsys = BS_sys + (4*t_jitter*Rx),

respectively.

Note 1: in all these equations, Rx, which is identical in definition to the same variable in the T-STD, is expressed in bytes/second for convenience.

Given the RTD buffers as defined above, and a system clock that fulfills the above requirements, the RTD imposes that all the buffer constraints imposed by the T-STD in part one of this Recommendation | International Standard be complied with. In addition, the buffer state of the buffer TB_m in the RTD at the arrival of the first byte of any Transport Stream packet shall be no more than the size of that buffer minus 188.

2.5 The value of t_jitter

The value of the constant t_jitter is 25 us.

3.0 Compliance Testing for RTI-LJ

3.1 Assumptions

This text assumes an RTI-LJ specification that is developed along the lines of ..... The actual parameters of the interface may be changed before the finalization of the text. These parameters (clock accuracy, slew rate, and PCR jitter) are referred to in the text below by variable names, D_f, R_slew, and t_jitter, respectively. The formulas that tie these parameters to certain buffer sizes, however, are supposed to remain fundamentally unchanged.

3.2 Objectives

The objectives of a testing procedure for the RTI specification are the following:

1. Test for compliance with the frequency accuracy spec.
2. Test for compliance with the slew rate spec.
3. Test for compliance with the PCR jitter spec.
4. Test for compliance with the buffer requirements.

For some streams, all of these requirements cannot be reached in the sense that it's not possible to measure them accurately enough or to separate them from each other. In principle, it can be said that streams need to have a certain length for the concept of compliance with all four points to have any meaning. The procedures for the different objectives are outlined briefly below.

3.3 Procedure

Frequency Accuracy, Slew Rate, and PCR jitter

1. The compliance test is carried out for one program at a time. The rest of the procedure is described for one program called P.
2. For each byte that carries the last bit of a PCR field for P, the arrival time of that byte and the value of the corresponding PCR itself are noted. These values are called t(i) and PCR(i), respectively.
3. When all PCR values in the segment of stream to be tested have been noted, these are plotted against their arrival values.
4. The stream is now compliant if a graph can be drawn such that its slope in each point is compliant with the requirement for STC frequency
5. accuracy; its curvature in each point is compliant with the requirement for maximum STC frequency slew; andits vertical distance to any of the points (t(i), PCR(i)) is not greater than t_jitter in any case.

Finding a graph such as in d. will sometimes be difficult. A stream is compliant whenever such a graph can be found, and a stream is not proven non-compliant until it can be proven that no such graph exists. This can be proven in some cases by for example taking a suspect point (t(i), PCR(i)) and draw a region which includes all other permissible points in the bitstream . If another point falls outside that region, the stream is non-compliant. A stream shall be assumed to be compliant unless it can be proven to be non-compliant.

3.4 Buffer Compliance

The buffer compliance test shall be performed exactly as the corresponding test for the T-STD, except for obvious changes due to different arrival times and buffer sizes, as well as the extra requirement for TB_r occupancy at the start of Transport Stream Packets.