International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.8272/Y.1367

Amendment 1
(08/2013)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Packet over Transport aspects – Quality and availability targets

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Internet protocol aspects – Transport

Timing characteristics of primary reference time clocks

Amendment 1

Recommendation ITU-T G.8272/Y.1367 (2012) – Amendment 1

ITU-T

International Telecommunication Union

ITU-T G-SERIES RECOMMENDATIONS

TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS	G.600–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
MULTIMEDIA QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DATA OVER TRANSPORT – GENERIC ASPECTS	G.7000–G.7999
PACKET OVER TRANSPORT ASPECTS	G.8000–G.8999
Ethernet over Transport aspects	G.8000–G.8099
MPLS over Transport aspects	G.8100–G.8199
Quality and availability targets	**G.8200–G.8299**
Service Management	G.8600–G.8699
ACCESS NETWORKS	G.9000–G.9999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T G.8272/Y.1367

Timing characteristics of primary reference time clocks

Amendment 1

Summary

Amendment 1 to Recommendation ITU-T G.8272/Y.1367 (2012) covers the case where the PRTC is integrated with a telecom grand master (T-GM) clock, therefore several clauses have been amended to reflect this.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.8272/Y.1367	2012-10-29	15	11.1002/1000/11817-en
1.1	ITU-T G.8272/Y.1367 (2012) Amd. 1	2013-08-29	15	11.1002/1000/12013-en

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T G.8272/Y.1367

Timing characteristics of primary reference time clocks

Amendment 1

1 Clause 1

Add the following sentence after the last paragraph of the scope:

This Recommendation also covers the case where a PRTC is integrated with a telecom grand master (T-GM) clock. In this case it defines the performance at the output of the combined PRTC and T-GM function, i.e., the PTP messages.

2 Clause 2

Add the following reference to clause 2:

[ITU-T G.8273] Recommendation ITU-T G.8273/Y.1368 (2013), *Framework of phase and time clocks*.

3 Clause 4

Add the following abbreviations:

PTP Precision Time Protocol

T-GM Telecom Grand Master

4 Clause 6

Add the following paragraph and note after the last paragraph of clause 6:

The performance specified in clauses 6.1 and 6.2 also applies to the output of the combined PRTC and T-GM function when integrated into a single piece of equipment. Therefore, there is no additional allowance for the inclusion of the T-GM function.

NOTE – Optimization of the noise inside the equipment is possible by combining the two functions. Therefore, the total noise of equipment that integrates the PRTC and T-GM can be the same as equipment that only contains the PRTC.

5 Clause 6.1

Replace the following paragraph:

Under normal, locked operating conditions, the time output of the PRTC should be accurate to within 100 ns or better when verified against of the applicable primary time standard (e.g., UTC). This value includes all the noise components, i.e., the constant time error (time offset) and the phase error (wander and jitter) of the PRTC.

With:

Under normal, locked operating conditions, the time output of the PRTC or combined PRTC and T-GM function should be accurate to within 100 ns or better when verified against of the applicable primary time standard (e.g., UTC). For the PRTC this value includes all the noise components, i.e., the constant time error (time offset) and the phase error (wander and jitter) of the PRTC. For the combined PRTC and T-GM function the same applies, except the samples are processed using the method specified in [ITU-T G.8273] to address timestamp quantization.

6 Clause 6.2

Add the following paragraph after the last paragraph of clause 6.2:

The applicable MTIE and TDEV requirements for an Ethernet interface carrying PTP messages are applied after averaging over at least 100 consecutive samples, to avoid errors caused by timestamp quantization, or any quantization of packet position in the test equipment.

7 Clause 9.1

Add the following bullet and note after the first bullet:

– Ethernet interface carrying PTP messages

NOTE – Ethernet interfaces can combine synchronous Ethernet for frequency and PTP messages.

8 Clause 9.2

Add the following bullet and note after the second to last bullet:

– synchronous Ethernet interfaces;

NOTE – Ethernet interfaces can combine PTP messages and synchronous Ethernet.

9 Appendix I

Replace Appendix I with the following appendix:

Appendix I

Measuring the performance of a PRTC and a PRTC combined with T-GM

(This appendix does not form an integral part of this Recommendation.)

The time error of a PRTC output is difficult to measure because time is a relative quantity. Unlike frequency, there is no such thing as a "time generator"; it always has to be compared back to a standard such as UTC. Even UTC itself is only known in retrospect, by comparing the outputs of many national time standards over a period of time.

NOTE 1 – The accuracy of the PRTC performance test is for further study.

NOTE 2 – The test details of a PRTC combined with T-GM is in [ITU-T G.8273].

I.1 Factors influencing the performance of a GNSS-based PRTC

The most common type of PRTC is one that distributes the time using radio signals from a GNSS system. However, the performance of a GNSS system is dependent on a range of issues outside the control of the equipment vendor. Therefore, any vendor specification can only indicate what the equipment is capable of, rather than what performance the equipment will actually deliver in any given installation.

In measuring the performance of a GNSS-based PRTC, the following conditions should be verified as far as possible:

- The equipment is properly commissioned and calibrated for fixed offsets such as antenna cable length and cable amplifiers. For example, an antenna cable will produce a delay of approximately 4 ns/m, depending on the cable type.
- Any 1PPS output signal asymmetry compensation contained within the PRTC (such as that described in clause A.1.2 of [ITU-T G.8271]) is stable.
- The antenna has a clear view of the sky with minimal multipath distortion. This may be verified by recording the number of satellites visible throughout the measurement.
- The GNSS or radio distribution system is properly maintained and operated by the relevant authorities. This may be verified by checking the operational status bulletins issued by the relevant operating authorities.

In addition to these primary factors, there are some secondary conditions which may cause errors in the time measured by a GNSS system. These factors may be more difficult to quantify or mitigate against. Secondary factors may include:

- interference from ground level transmissions. While filters may be used to remove some ground level interference, this may not protect against local jamming. The presence of jamming may be verified by using interference detection equipment;
- atmospheric conditions such as thunderstorms and heavy rain or fog;
- solar interference such as sunspots and flares, affecting ionosphere delay.

I.2 Phase wander measurement

It is possible to measure the phase wander of a PRTC relative to a PRC-quality frequency reference, such as a caesium clock. A time interval counter is used to compare the phase of a 1 pulse-per-second (1PPS) output signal from the PRTC against that of a PRC. The experimental set-up is shown in Figure I.1:

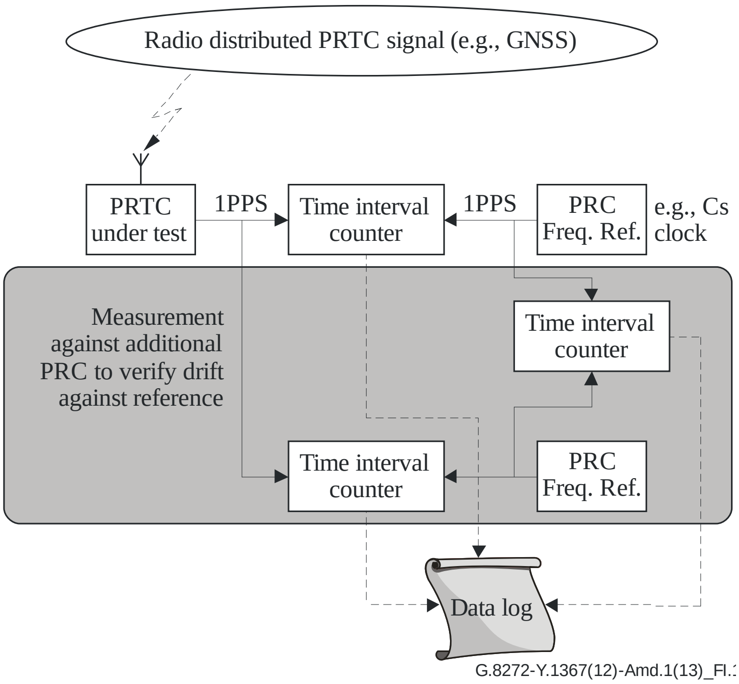

Figure I.1 – Measuring phase wander of a PRTC

Where a combined PRTC and T-GM function is to be tested, the time interval counter can be replaced by a packet timing monitor device, as shown in Figure I.2:

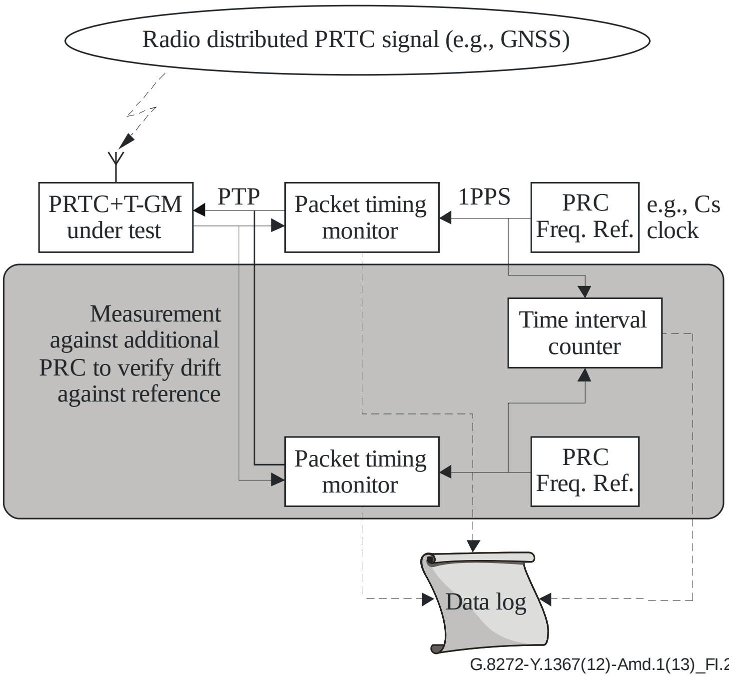

Figure I.2 – Measuring phase wander of a combined PRTC and T-GM

The wander of a caesium reference clock is extremely low, although it may have a slight offset to UTC frequency. For a PRC, this is guaranteed to be within 1 part in 10^{11}, but typical caesium references have much better performance. This frequency offset causes a tilt in the phase plot, which must be removed to reveal the wander performance of the PRTC.

In order to distinguish between wander of the PRTC and that of the PRC, a second PRC can be used to make a three-way comparison. This is shown in Figures I.1 and I.2 by the components in the shaded boxes. This additional check may be omitted if not required.

Since the caesium reference is only a source of frequency and not time, this experiment only indicates phase wander, and cannot measure the time error from the GNSS system time. However, it does indicate that if the static error can be measured and calibrated out, the PRTC is capable of maintaining time within certain limits.

I.3 Time error measurements

In order to determine the maximum time error of a PRTC, it is necessary to compare it to another source of accurate time.

I.3.1 Comparison against a reference receiver

In the laboratory context, an accurate source of time might be another GNSS receiver of known uncertainty, or a "reference receiver". The experimental set-up is very similar to the wander measurement, but substituting the reference receiver for the caesium PRC. A time interval counter is used to compare the time difference of a 1 pulse-per-second (1PPS) output signal from the PRTC against that of the reference receiver. The experimental set-up is shown in Figure I.3:

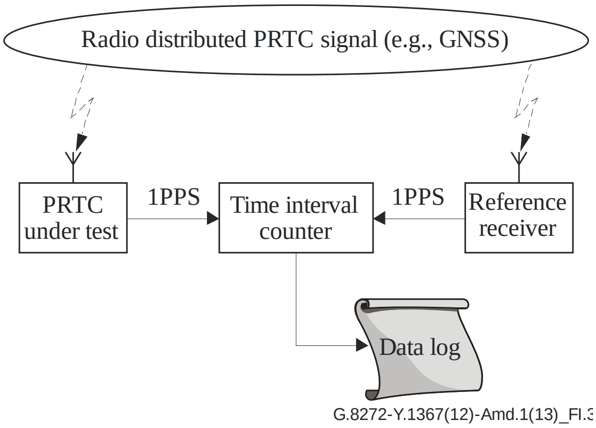

Figure I.3 – Comparing time accuracy against a reference receiver

As before, for a combined PRTC and T-GM function, the time interval counter can be replaced by a packet timing monitor, as shown in Figure I.4 below:

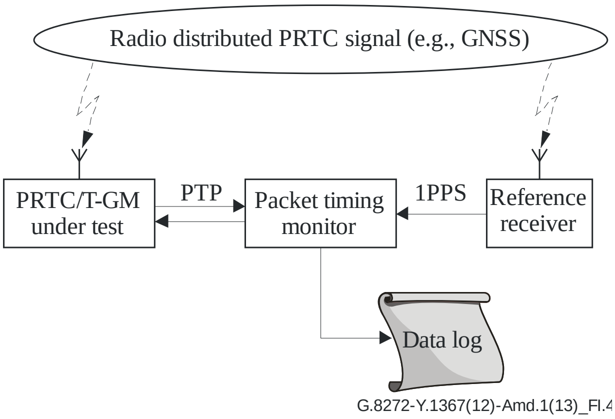

Figure I.4 – Comparing time accuracy of a PRTC and T-GM against a reference receiver

In this set-up, the reference receiver should ideally have a significantly better performance than the PRTC in order for the results to be valid. Since the PRTC time error specification is approaching the limits of what is possible using a GNSS system, this type of measurement is able to give an indication that the time accuracy is in the right area, rather than prove that the accuracy specification has been met.

The reference receiver approach may be improved by using a collection of reference receivers. For example, if three receivers or more are used, it is possible to use a "majority voting" system to determine the performance of the PRTC under test. It is also possible to estimate the variance of individual receivers. The experimental set-up is shown in Figure I.5.

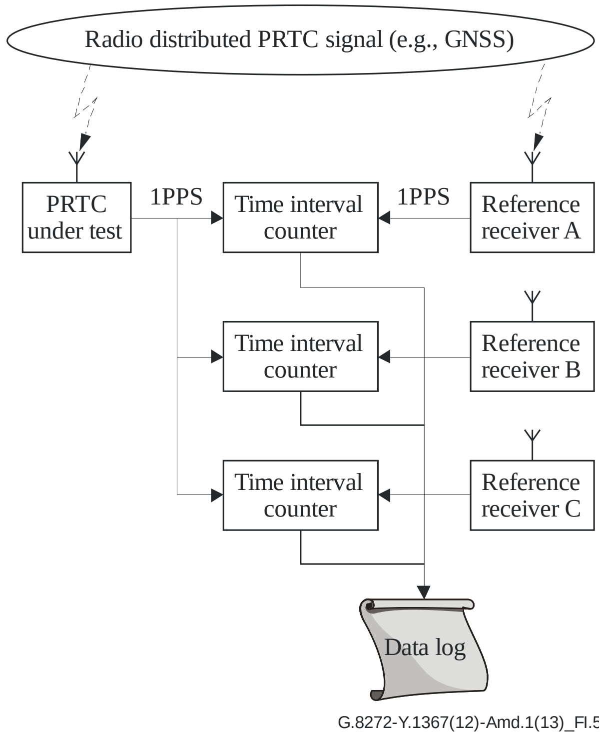

Figure I.5 – Comparing time accuracy against multiple reference receivers

As before, for a combined PRTC and T-GM function, the time interval counters can be replaced by packet timing monitors.

I.3.2 Calibration against national time standard

In order to prove that the time error relative to a given time standard is within acceptable limits, it is necessary to compare the PRTC to a much more accurate source of time. For example, this may be obtained from a national time laboratory. Either the measurement will need to be made at the laboratory itself, or an accurate time distribution system will need to be used, such as dedicated cable or fibre, or a GNSS common-view time service. This type of measurement may be used to characterize the performance of a reference receiver. The experimental set-up is shown in Figure I.6.

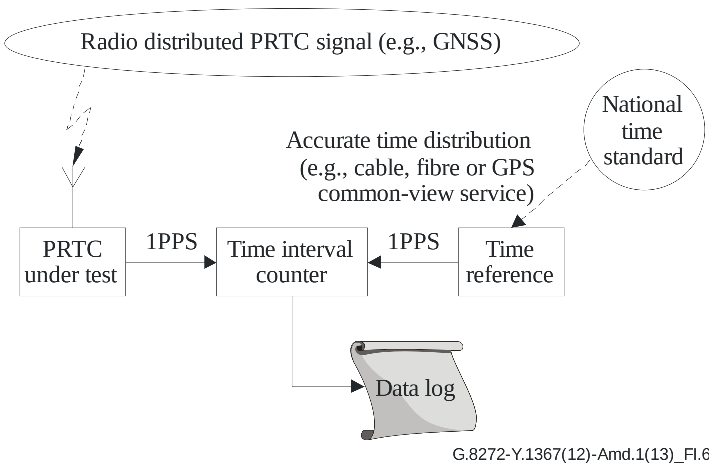

Figure I.6 – Measuring time accuracy against a national time standard

As before, for a combined PRTC and T-GM function, the time interval counters can be replaced by a packet timing monitor.

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	**Y.1300–Y.1399**
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Enhancements to NGN	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Packet-based Networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999
FUTURE NETWORKS	Y.3000–Y.3499
CLOUD COMPUTING	Y.3500–Y.3999

For further details, please refer to the list of ITU-T Recommendations.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	**Transmission systems and media, digital systems and networks**
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	**Global information infrastructure, Internet protocol aspects and next-generation networks**
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2014