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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Gateway control protocol: Guidelines for synchronized time in ITU-T H.248 domains

ITU-T H-series Recommendations – Supplement 8

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Supplement 8 to ITU-T H-series Recommendations

Gateway control protocol: Guidelines for synchronized time in ITU-T H.248 domains

Summary

Supplement 8 to ITU-T H-series Recommendations defines a time coordination function that may be used by an application process and/or a gateway control protocol in a decentralized gateway environment such as ITU-T H.248 decomposed gateways.

Within the working assumptions defined, this supplement establishes a time coordination function model, addressing the components of a generic time service involving communication between gateway and gateway controller entities that relate the service and generic definitions provided by this function to the user requirements. It also identifies time synchronization protocols. The scope of this supplement is on "time of day" information, not on other elements related to timing. Further more, the provision of time information within a local system and implementation aspects are also out of the scope of this supplement.

Source

Supplement 8 to ITU-T H-series Recommendations was agreed on 2 May 2008 by ITU-T Study Group 16 (2005-2008).

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Gateway control protocol: Guidelines for synchronized time in ITU-T H.248 domains

1 Scope

This supplement defines a time coordination function that may be used by an application process and/or a gateway control protocol in a decentralized gateway environment such as decomposed gateways according to [ITU-T H.248.1].

This supplement:

– establishes user requirements for this synchronized time in ITU-T H.248 domains;

– establishes a time coordination function model, addressing the components of a generic time service involving communication between gateway and gateway controller entities, that relates the service and generic definitions provided by this function to the user requirements;

– identifies time synchronization protocols.

This supplement does not:

– address the provision of time information within a local system;

– define the nature of any implementation intended to provide the time coordination function.

The scope of this supplement is on "time of day" information, not on other elements related to timing.

1.1 Explicitly out of scope

Synchronized time is typically relevant not only for the gateway control protocol and ITU-T H.248 interfaces. Timing and synchronization aspects for ITU-T H.248 entities may be also required, however subsequent functions and interfaces are out of scope.

1.1.1 Transmission layer

ITU-T H.248 entities are connected to packet and/or circuit networks. Timing, timing distribution and synchronization aspects in packet networks are very different in comparison to circuit-switched networks. Such aspects for transmission layer technologies are addressed, e.g., by ITU-T G-series Recommendations. For instance, [ITU-T G.8261], [ITU-T G.8262], [ITU-T G.8264] could be relevant for particular deployments of ITU-T H.248 entities.

The transmission layer aspects and technologies are out of scope.

1.1.2 User plane

User plane protocols may carry time information. For instance, application-level framing protocols (e.g., IETF RTP, 3GPP-specific framing protocols) for real-time transport require time synchronization elements between source and sink (e.g., synchronization aspects between an RTP end system and an ITU-T H.248 RTP termination).

Synchronization aspects or time alignment procedures of such types of user plane protocols are out of scope.

1.1.3 Management plane

Without synchronized time, accurately correlating information between network elements becomes difficult, if not impossible (Note). Management and management systems for ITU-T H.248 entities are out of scope here.

NOTE – For instance, comparison of log files between network elements requires synchronized times. Particularly when it comes to security issues, reliable information may be only derived on the basis of accurate timing information.

1.1.4 Relation to technologies for high precision time distribution for IP networks

This supplement makes proposals for time distribution technologies that are sufficient to cover the requirements addressed by this supplement. These technologies themselves are evolving and may be relevant for IP networks with higher precision time, but not in this supplement for the considered ITU-T H.248 control association.

NOTE – Such IP-specific technologies will be, e.g., developed by the IETF working group "Transmitting Timing over IP Connections and Transfer of Clock" (TICTOC).

2 References

[ITU-T G.810] Recommendation ITU-T G.810 (1996), *Definitions and terminology for synchronization networks.*
<http://www.itu.int/rec/T-REC-G.810>

[ITU-T G.8261] Recommendation ITU-T G.8261/Y.1361 (2008), *Timing and synchronization aspects in packet networks.*
<http://www.itu.int/rec/T-REC-G.8261>

[ITU-T G.8262] Recommendation ITU-T G.8262/Y.1362 (2007), *Timing characteristics of synchronous Ethernet equipment slave clock (EEC).*
<http://www.itu.int/rec/T-REC-G.8262>

[ITU-T G.8264] Recommendation ITU-T G.8264/Y.1364 (2008), *Distribution of timing information through packet networks.*
<http://www.itu.int/rec/T-REC-G.8264>

[ITU-T H.248.1] Recommendation ITU-T H.248.1 v3 (2005), *Gateway control protocol: Version 3.*
<http://www.itu.int/rec/T-REC-H.248.1>

[ITU-T H.248.47] Recommendation ITU-T H.248.47 (2008), *Gateway control protocol: Statistic conditional reporting package.*
<http://www.itu.int/rec/T-REC-H.248.47>

[ITU-T X.743] Recommendation ITU-T X.743 (1998) | ISO/IEC 10164-20:1999, *Information technology – Open Systems Interconnection – Systems Management: Time Management Function.*
<http://www.itu.int/rec/T-REC-X.743>

[ITU-T X.751] Recommendation ITU-T X.751 (1995) | ISO/IEC 10164-17:1996, *Information technology – Open Systems Interconnection – Systems Management: Changeover function.*
<http://www.itu.int/rec/T-REC-X.751>

[ITU-T Y.1540] Recommendation ITU-T Y.1540 (2007), *Internet protocol data communication service – IP packet transfer and availability performance parameters.*
<http://www.itu.int/rec/T-REC-Y.1540>

[ETSI TR 183 025] ETSI TR 183 025 (2007), *Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); H.248 Non-Call Related Procedures and Management System Interaction.*
<http://portal.etsi.org/docbox/TISPAN/Open/NGN_LATEST_DRAFTS/RELEASE2/03193-ngn-r2v230.pdf >

[IETF RFC 3339] IETF RFC 3339 (2002), *Date and Time on the Internet: Timestamps*.
<http://www.ietf.org/rfc/rfc3339.txt>

[IETF RFC 1305] IETF RFC 1305 (1992), *Network Time Protocol (Version 3) – Specification, Implementation and Analysis.*
<http://www.ietf.org/rfc/rfc1305.txt>

[IETF RFC 4330] IETF RFC 4330 (2006), *Simple Network Time Protocol (SNTP) Version 4 for IPv4, IPv6 and OSI.*
<http://www.ietf.org/rfc/rfc4330.txt>

[IETF RFC 3550] IETF RFC 3550 (2003), *RTP: A Transport Protocol for Real-Time Applications.*
<http://www.ietf.org/rfc/rfc3550.txt>

[ISO 8601] ISO 8601:2004, *Data elements and interchange formats – Information interchange — Representation of dates and times.*
<http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=40874>

3 Definitions

3.1 Terms defined elsewhere

This supplement uses the following terms defined elsewhere:

3.1.1 actual clock rate [ITU-T X.743]: The actual clock rate is the frequency or rate at which a clock increments, including any modifications resulting from frequency adjustment or clock training. The actual clock rate is equivalent to the basic clock rate in the absence of or prior to any frequency adjustment modifications.

3.1.2 accuracy [ITU-T X.743]: Accuracy is a measure of how well a local clock's time value and frequency compare to UTC.

3.1.3 adjustment rate [ITU-T X.743]: Adjustment rate is the frequency or rate at which a single time adjustment is applied to the local clock.

3.1.4 basic clock rate [ITU-T X.743]: The basic clock rate is the frequency or rate at which a clock increments in the absence of any modifications resulting from frequency adjustment.

3.1.5 coordinated universal time (UTC) [ITU-T X.743]: The time reference that is assumed to be universally correct. UTC was adopted by CCIR Recommendation 470 and described in CCIR Report 517. This is not the ASN.1 representation of generalized time.

3.1.6 correct clock [ITU-T X.743]: A clock where the absolute value of the error is less than its maximum error.

3.1.7 frequency offset [ITU-T X.743]: The first derivative of the clock's error. That is, the frequency offset is the actual rate of change of error of the clock.

3.1.8 error of a clock [ITU-T X.743]: The time offset between the clock's reading and UTC at a given instant.

3.1.9 functioning clock [ITU-T X.743]: A clock in which either the frequency offset is within the maximum frequency error of the clock or the clock is undergoing an adjustment. A functioning clock may be correct or incorrect.

3.1.10 granularity [ITU-T X.743]: The maximum precision permitted by a representation of time.

3.1.11 local clock [ITU-T X.743]: The collection of hardware and software that comprises a local source of time for a system.

3.1.12 maximum drift of a clock [ITU-T X.743]: The manufacturer's specified maximum value of frequency offset.

3.1.13 maximum error of a clock [ITU-T X.743]: The maximum error bound of the absolute value of the error of a clock.

3.1.14 precision [ITU-T X.743]: The smallest value by which a clock changes.

3.1.15 rapport [ITU-T X.743]: The state when the local clock is correct and the maximum error of the clock is within the user specified maximum error.

3.1.16 synchronization domain [ITU-T X.743]: The set of local clocks involved in the exchange of time information for the purposes of coordination. This includes local clock and clock coordination resources. The members of this set are defined by administrative, platform, or environmental considerations.

3.1.17 synchronization source [ITU-T X.743]: The source chosen by an algorithm of policy for time synchronization.

3.1.18 time offset [ITU-T X.743]: The algebraic difference between the readings of two clocks at a given instant in time.

3.2 Term defined in this supplement

This supplement defines the following term:

3.2.1 ITU-T H.248 (time) domain: A collection of ITU-T H.248 entities given by a primary media gateway controller (MGC) and all assigned primary and secondary media gateways (MGs) to this MGC, and in addition all potential secondary MGCs for the primary MGC.

NOTE 1 – This definition reflects that primarily synchronized time is required between a) the MGC and assigned MGs, and between b) primary and secondary ITU-T H.248 entities. Potential time synchronization between different ITU-T H.248 domains is out of scope.

NOTE 2 – A single ITU-T H.248 time domain may be distributed over multiple time zones.

4 Abbreviations and acronyms

This supplement uses the following abbreviations and acronyms:

3G CS CN	Third Generation mobile Circuit-Switched Core Network (domain)
BICC	Bearer Independent Call Control
CA	Control Association (ITU-T H.248)
DA	Destination Address (Internet Protocol)
DORIS	Doppler Orbitography and Radio-positioning Integrated by Satellite
DP	Destination Port (Internet Protocol)
DTS	Distributed Time Service
GLONASS	GLObal NAvigation Satellite System
GPS	Global Positioning System
H	Host (IP)
IMS	Internet Protocol Multimedia Subsystem
IS	In-Service (ITU-T H.248)
MG	Media Gateway
MGC	Media Gateway Controller

MP	Measurement Point
NGN	Next Generation Network
NTP	Network Time Protocol
OoS	Out-of-Service (ITU-T H.248)
PCS	Probabilistic Clock Synchronization
PDV	Packet Delay Variation
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
R	Router (Internet Protocol)
RR	Reporting Point
RTCP	Real-time Transport Control Protocol
RTP	Real-time Transport Protocol
SA	Source Address (Internet Protocol)
SIP	Session Initiation Protocol
SIP-I	Session Initiation Protocol with encapsulated Integrated Services digital network – User Part
SP	Source Port (Internet Protocol)
SC	ServiceChange (ITU-T H.248)
UTC	Coordinated Universal Time

5 Conventions

None.

6 Problem for distributed systems (such as decomposed gateways)

Decomposed gateways, according to the ITU-T H.248 partitioning model, are distributed systems, sharing therefore similar requirements with regard to distributed time and synchronized time between media gateways and their assigned control entities. The distributed MGC and MG are loosely-coupled in the control plane via their ITU-T H.248 control association (CA), and also somehow coupled via network management systems (see, e.g., [ETSI TR 183 025]).

6.1 General aspects for distributed systems

The general aspects are postulated in [ITU-T X.743]. This clause recalls the most important ones.

Systems management functions have requirements to record accurately the time of occurrence of alarm notifications, fault event notifications, summarization notifications and access of the attribute values of managed objects. Observations of attribute values of managed objects can be the time of access of attribute value, time that attribute value was changed and time interval calculations. Also, system management includes the scheduling of managed objects. Scheduling includes the control of object attributes such as start-time, stop-time, begin-time and end-time, and involves the tracking of seconds, hours, weeks, months and years. In addition, applications beyond the scope of systems management require a stable robust time service.

The service objective of the time management function (see also clause 7) is to provide correct, accurate and stable time among systems. The implementation of the time management function is normally consistent with the user's communication system application.

6.2 Specific for distributed gateways (according to ITU-T H.248.1)

Figure 1 provides an overview of time information used between ITU-T H.248 entities, and between ITU-T H.248 entities and their environment.

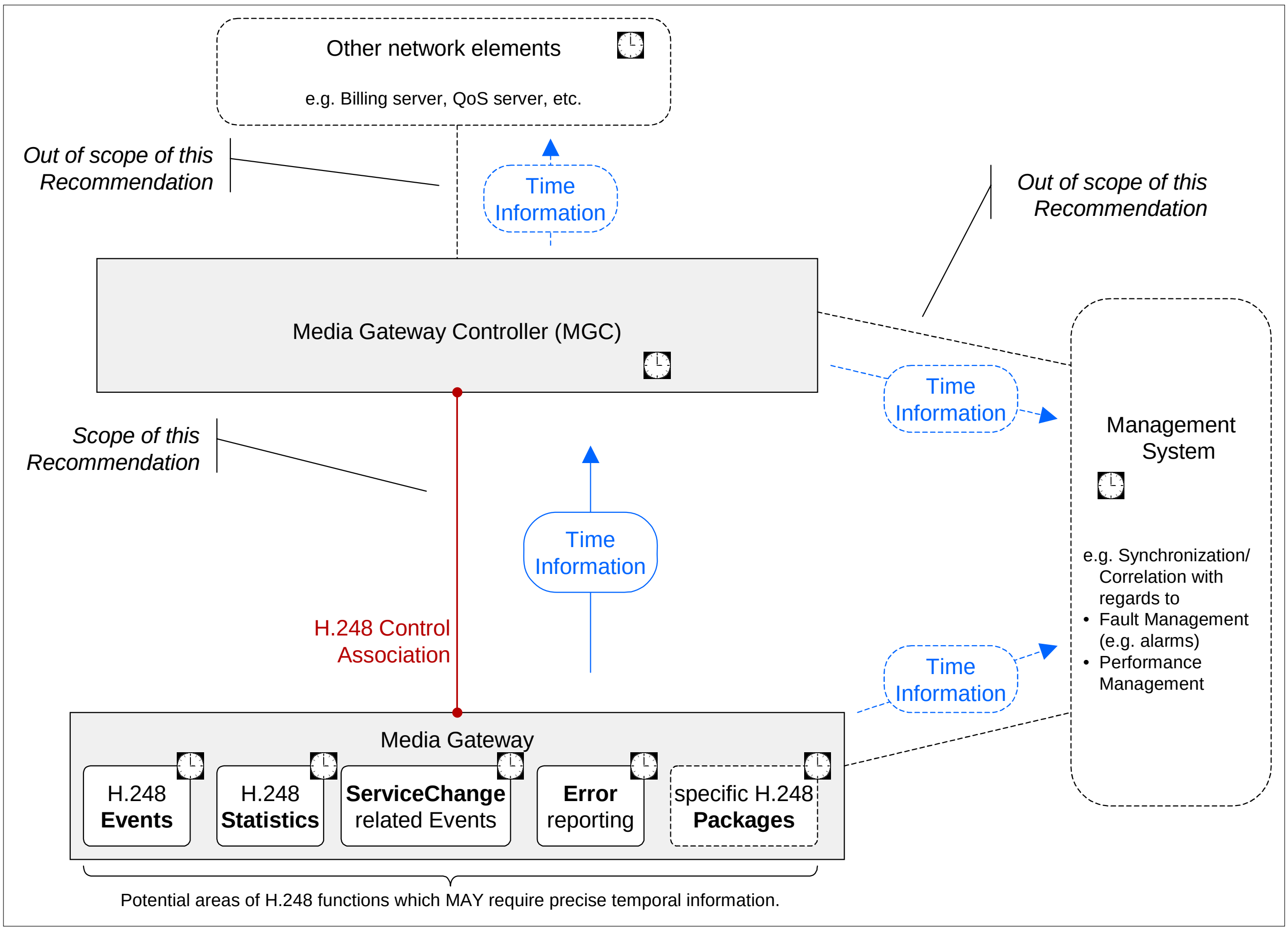

Figure 1 – Distribution of time information in ITU-T H.248 decomposed gateways

This supplement focuses only on the exchanged time information at the ITU-T H.248 control association and synchronized time between an MGC and assigned MGs. The problem of, and requirements for, time synchronization requirements may also be relevant for the other control and management plane interfaces indicated in Figure 1, but they are not discussed by this supplement. Those interfaces may have different requirements, but it may be noted that the solution proposed here is generally applicable.

6.3 Functional areas with precise temporal information between ITU-T H.248 entities

Figure 1 summarizes potential areas that MAY require precise temporal information:

– ITU-T H.248 *Events* and their:

a) immediate, *realtime* notification; or their

b) *time-stamped* reporting (e.g., usage of an *EventBuffer* for queueing events along with their detection time and a later notification, see clause 7.1.9 of [ITU-T H.248.1]);

– ITU-T H.248 *Statistics*, e.g., periodical *realtime* statistics reporting according to [ITU-T H.248.47];

– ITU-T H.248 *ServiceChange* (Note) related events;

– ITU-T H.248 *Error* reporting;

– dedicated ITU-T H.248 *Packages*, which provide accurate time-controlled functions (e.g., a function like "start signal at time t = …"); or

– others.

NOTE – The *TimeStamp* parameter may be inserted in *ServiceChange.request* commands, see clause 7.2.8.1.7 of [ITU-T H.248.1]. This allows the receiver to identify the time difference (offset) between both ITU-T H.248 entities. Using synchronized time within an ITU-T H.248 domain (see clause 9) may allow the ability to reduce the time difference to an insignificant value, and the observation of the ITU-T H.248 message transfer delay from sender to receiver.

7 Requirements

Requirements for time management and time synchronization are already defined by [ITU-T X.743]. These requirements are basically valid for network elements in NGNs as well. These requirements could be slightly simplified for ITU-T H.248 entities due to:

– the protocol syntax given (see clause 7.1) by ITU-T H.248.1, and due to

– the limited scope on ITU-T H.248 control association and ITU-T H.248 domains only in this supplement.

7.1 Time representation requirements

The time representation at the ITU-T H.248 control association between ITU-T H.248 entities is given by the ITU-T H.248 protocol syntax, which uses a specific format [ISO 8601]:

```
TimeStamp            = Date "T" Time ; per ISO 8601:2004
Date                 = 8(DIGIT) ; Date = yyyymmdd
Time                 = 8(DIGIT) ; Time = hhmmssss
```

The time representation in ITU-T H.248 entities shall be compliant with [ITU-T H.248.1].

7.2 Time accuracy and precision requirements

The maximum meaningful time precision at the ITU-T H.248 control association between ITU-T H.248 entities is given by the time format of the timestamp syntax, which defines four digits for the *seconds* field, leading to a "precision of hundredths of a second".

ITU-T H.248 entities shall therefore support a time granularity of 10 ms or better.

7.2.1 Higher precision requirements for ITU-T H.248 MGs as measurement points

Reported ITU-T H.248 statistics may be based on local (near-end) or remote (far-end) measurements from the MG perspective. The ITU-T H.248 interface relates, for both cases, to the reporting point (RP). For local measurements the MG behaves as a measurement point (MP).

The MG role may lead to higher precision requirements, which are given by the data type and value range of the correspondent ITU-T H.248 statistics. The following clauses provide typical examples in this area.

7.2.1.1 Time granularity based on RTP timestamp units

The "timestamp" is related to the RTP packet header field "timestamp", as defined in clause 5.1 of [IETF RFC 3550]. This timestamp correlates with the sampling instant. The "timestamp unit" is typically of type integer in correspondent ITU-T H.248 statistics. The relation between the "timestamp unit" and the correspondent "time unit" is typically media format (e.g., codec type) dependent. Examples are given in Table 1.

Table 1 – Examples of sampling frequency and associated timestamp unit

Sampling frequency	Timestamp unit
8.000 kHz	125.0 µs
11.025 kHz	90.7 µs
16.000 kHz	62.5 µs
22.050 kHz	45.4 µs
24.000 kHz	41.6 µs
32.000 kHz	31.25 µs
44.100 kHz	22.7 µs
48.000 kHz	20.8 µs

The media format is typically defined on ITU-T H.248 stream or termination level.

7.2.1.2 Time granularity given by a defined resolution of a metric

In the case of an *absolute* time unit (e.g., in milliseconds), but with a fixed-fractional data type, it leads to a resolution below the time unit.

For example, the statistic for a discussed RTCP metric "mean PDV" is a 16-bit type with S11:4 format and expressed in milliseconds, which leads to a time granularity of 62.5 µs.

7.3 Synchronization domain requirements

7.3.1 Synchronized time within an ITU-T H.248 domain

Time synchronization shall be limited on a *synchronization domain*. The *members* of such a synchronization domain are given by *H.248 entities* and additional *time servers*. The considered synchronization domains relate to an ITU-T H.248 (time) domain, illustrated in Figure 2, and defined in clause 3.1.16.

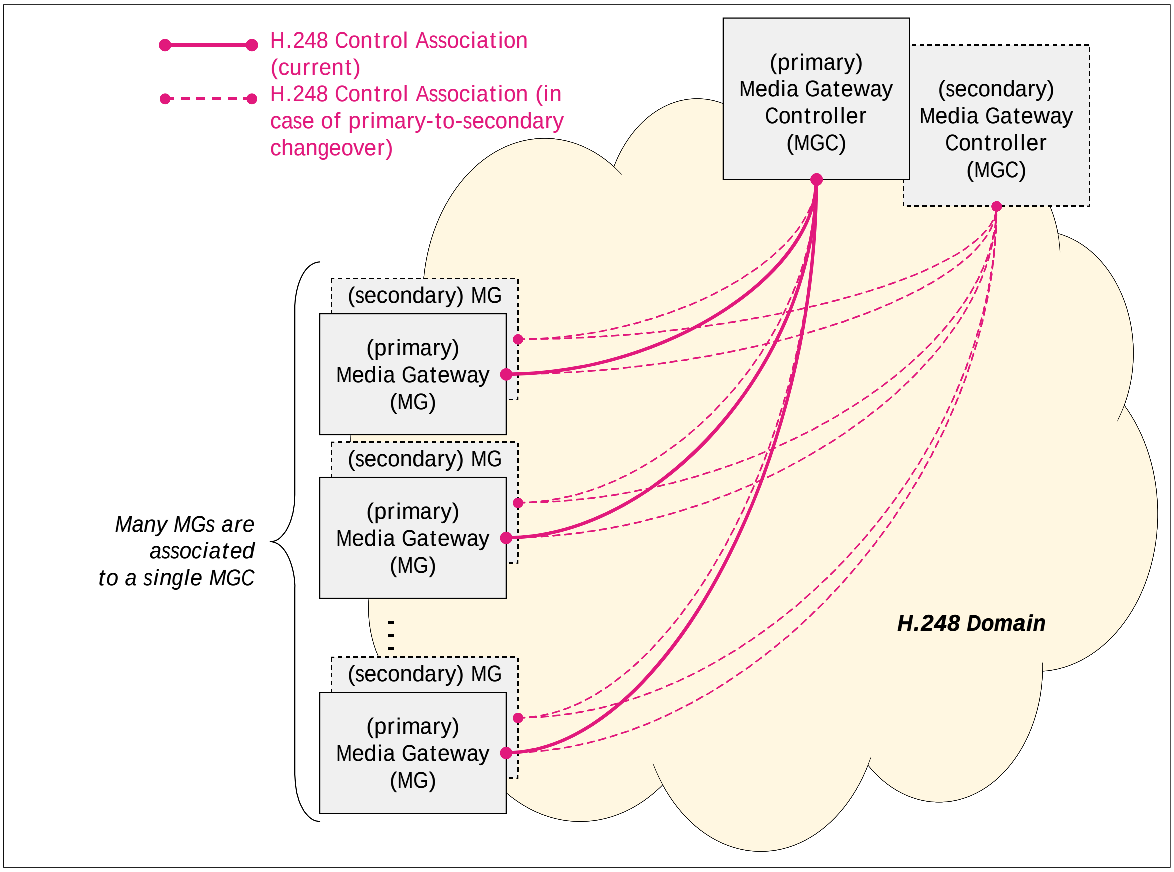

Figure 2 – ITU-T H.248 domain concept

Engineering a network for time synchronization must consider at least a single ITU-T H.248 domain.

7.3.2 Synchronized time between ITU-T H.248 domains

A network domain (such as a single PSTN emulation subsystem instance, an IMS instance, a PLMN domain such as a 3G R4 CS CN domain, etc.) may be comprised of multiple ITU-T H.248 domains, given by the number of primary MGC instances per domain. In that case, the various ITU-T H.248 domains are coupled in the control plane by call/session control protocols (such as e.g., SIP, SIP-I, BICC) as MGC-to-MGC signalling. Time information may also be carried over MGC-to-MGC interfaces, but this is out of scope of this supplement.

Requirements for synchronized time between ITU-T H.248 domains are out of scope of this supplement. Nevertheless, the solution provided could in principle be applied as well to multiple ITU-T H.248 domains, an NGN, an administrative domain, etc.

7.4 Time distribution requirements

Clause 6.3 of [ITU-T X.743] is relevant for ITU-T H.248 entities.

7.5 Time service reliability requirements

Clause 6.4 of [ITU-T X.743] is relevant for ITU-T H.248 entities.

7.6 Local clock requirements

The implementation of a local clock in an ITU-T H.248 MGC or MG is outside the scope of this supplement. However, in order to support the time synchronization function, a local clock has the following requirements: see clause 6.5 of [ITU-T X.743].

7.7 Availability requirement for accurate time after ITU-T H.248 restart or registration

Time synchronization protocols (see clause 9.2.1) for clock coordination may have rather long convergence times (e.g., in the range of hours is often not unusual), which may need consideration. For instance, there is a qualitative requirement of synchronized time between ITU-T H.248 entities as soon as an ITU-T H.248 control association is successfully established (which is typically related to ITU-T H.248 registration or re-registration procedures (see Annex F of [ITU-T H.248.1]).

7.8 Availability requirement for accurate time after creation of an ITU-T H.248 stream or termination

ITU-T H.248 MGs could behave as measurement points (see clause 7.2.1) for traffic on non-root terminations. The measurement of specific metrics requires a time reference. The time reference may be derived from the:

a) incoming media flow;

b) incoming control flow (e.g., see proposals in IETF for time alignment using RTCP feedback); or

c) local clock.

The common availability requirement for an accurate time basis could be formulated as follows: the time reference must be accurate as soon as the bearer is cutthrough or the StreamMode allows the MG to receive traffic (Note). This implies very fast availability requirements.

NOTE – The underlying motivation is the so-called "population of interest" (see clause 6.1.1 of [ITU-T Y.1540]), which is relevant for packet networks. For example, for ITU-T H.248 IP streams/terminations, most of the performance parameters are defined over sets of packets called populations of interest. For the ITU-T H.248 IP streams/termination, the population of interest is usually the *total set of packets* being sent and/or received (dependent on specific performance parameter). "Total" means the availability of an accurate time reference only with arrival (or departure) of the first packet.

7.8.1 Measurements at ITU-T H.248 TDM terminations

Method a may be applied to the availability of clock reference at circuit-switched interfaces.

7.8.2 Measurements at ITU-T H.248 RTP terminations

Method a is typically not applicable due to the rather long convergence times for time derivations based on RTP flows. Thus, method c should be used.

8 Model

The purpose of the time synchronization function is to manage the resources related to the provision of quality time information in a system. In this clause, the generic functionality involved in the provision of time information is defined and the components of that functionality that are within the scope of the time synchronization function are identified. The time-related resources in an ITU-T H.248 entity are identified. A model for the time synchronization function is provided, and the clock coordination function is defined.

8.1 MGC-MG model

The starting point is the basic ITU-T H.248 model for a single MGC-MG tandem as outlined in Figure 3. Time alignment between MGC and MG is achieved by clock synchronization.

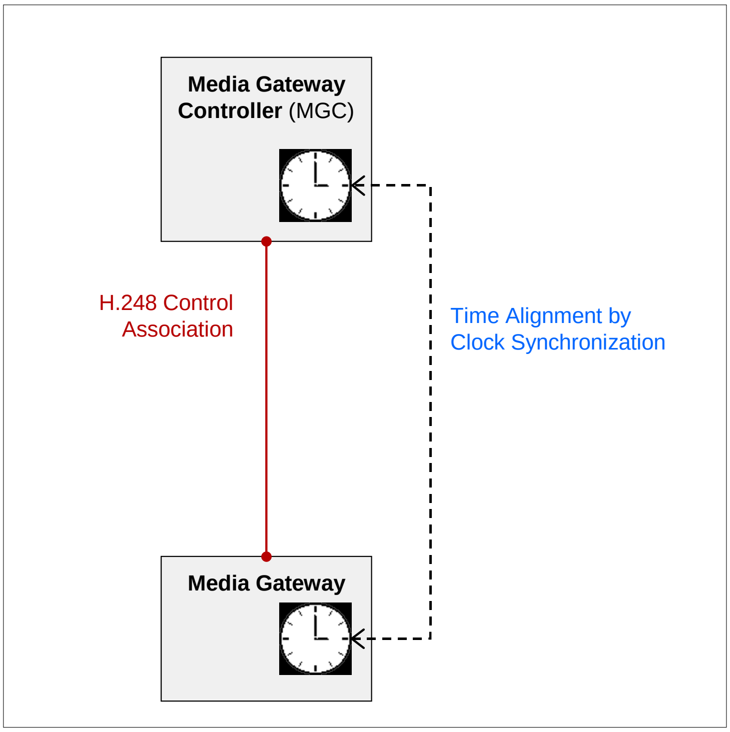

Figure 3 – MGC-MG model

The foundation of all functions related to time synchronization is a clock which includes a *local clock* and optionally *external time references*. Details are outlined in clause 7.1 of [ITU-T X.743]. Figure 4 (taken from Figure 1 of [ITU-T X.743]) recalls the generic time functionality: "System" relates to an ITU-T H.248 entity and "user" relates to the ITU-T H.248 protocol and served user instances. The "time management functions" are out of scope of this supplement.

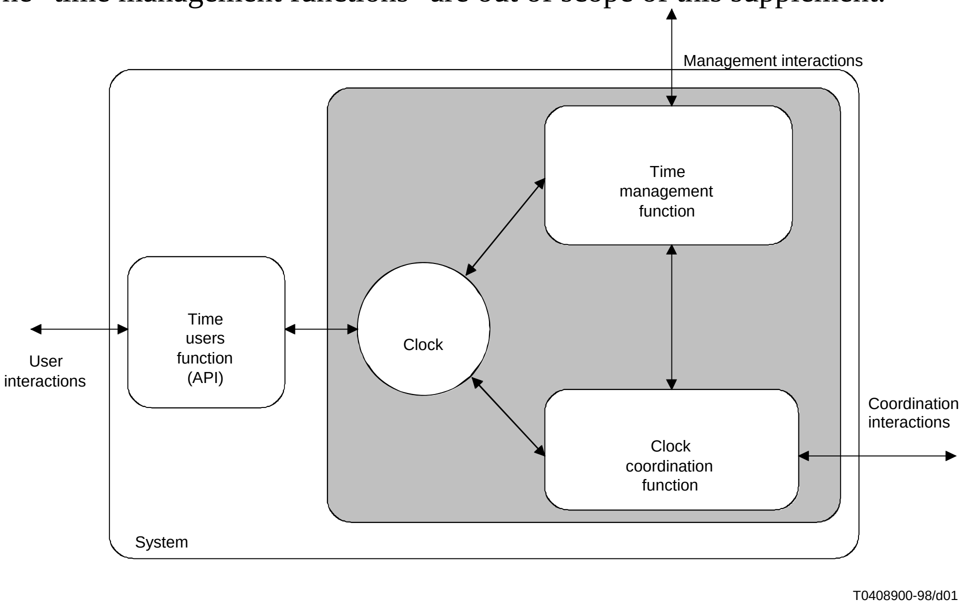

Figure 4 – Generic time functionality (from Figure 1 of [ITU-T X.743])

Figure 5 below shows an extended MGC-MG model inclusive of the indication of the generic time functionality and additionally an *external* time server.

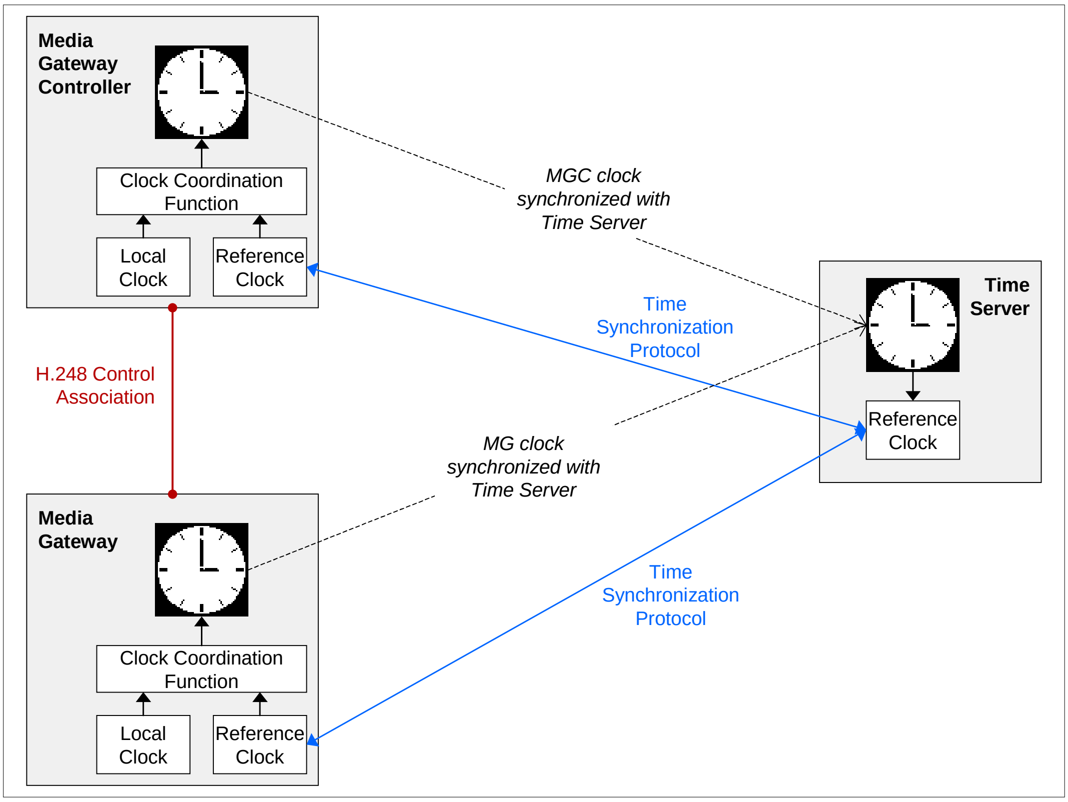

Figure 5 – MGC-MG model with external time server

8.2 Time alignment concept for a MGC-MG pair

Time alignment between an MGC and MG can be achieved when the MG synchronizes its clock *directly* (as indicated in Figure 3) with the MGC's clock as reference clock or vice versa. The MGC or the MG, respectively, would then provide the *synchronization source* function.

NOTE – Only the first case has practical relevance. The second case implies a single MG per MGC, which is rather an exceptional deployment case.

A more advantageous time alignment concept, better suited for ITU-T H.248 domains, is based on an *indirect* clock synchronization, using separate time server(s). This is depicted in Figure 5: the MGC and the MG clock are synchronized with the clock of the external time server as synchronization source. The synchronization is fundamentally based on a time synchronization protocol.

8.3 ITU-T H.248 time domain model and time alignment concept

An ITU-T H.248 domain is constituted usually by more than a single MG and single MGC, as introduced in clause 7.3.1. This implies the necessity for clock synchronization between more than two ITU-T H.248 entities. Figure 6 illustrates an example of an ITU-T H.248 domain with the primary MGC, and:

– *k* associated secondary MGCs; and

– *N* assigned MGs in "primary-only" configurations (i.e., there is no secondary MG in this ITU-T H.248 domain).

Time alignment should be separated into two areas (Figure 6):

a) All slave instances (i.e., the MGs) should be time-aligned with the present primary MGC. Such a slave-to-master clock synchronization follows the ITU-T H.248 master-slave control relationship.

b) Primary and secondary MGCs should be mutually time-aligned in general. The reason for this is that usually a secondary MGC provides in parallel the primary MGC role (in another ITU-T H.248 domain).

NOTE 1 – Such a configuration is the starting point for geographical redundancy on the MGC level: primary MGC entities acting as backup capability (see also clause 7.1.1 of [ITU-T X.751]), that means as secondary MGCs for other primary MGCs in other geographical or ITU-T H.248 domains.

NOTE 2 – An MGC may thus belong to more than one ITU-T H.248 domain. This may imply time coordination between ITU-T H.248 domains (see clause 7.3.2).

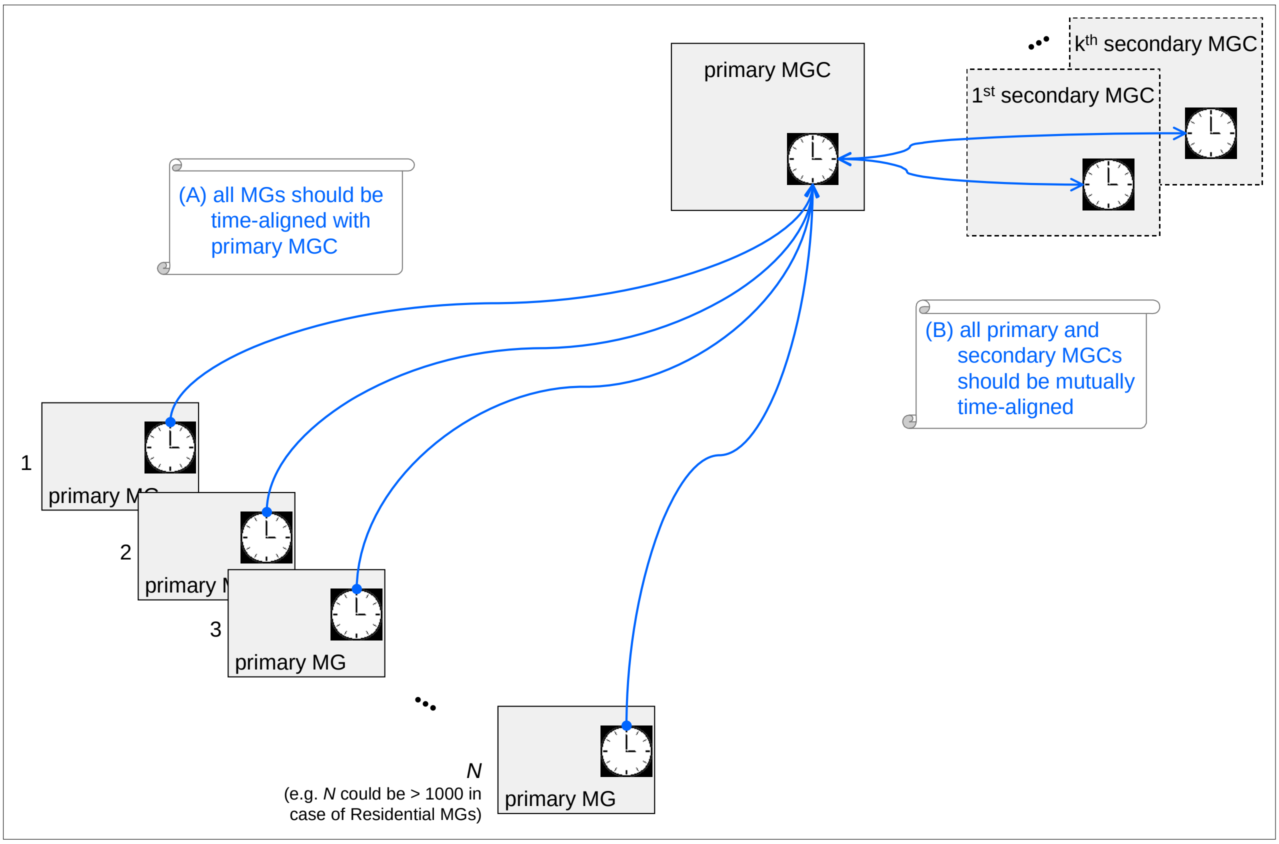

Figure 6 – ITU-T H.248 time domain model and time alignment concept

9 Possible solutions for clock coordination within ITU-T H.248 domains

The clock coordination function provides the coordination of clocks for the purposes of time synchronization [ITU-T X.743].

9.1 Introduction

There are two resources related to the provision of time information:

a) clocks (either local clocks or external time references (see clause 7.2.1 of [ITU-T X.743]); and

b) clock coordination tools.

ITU-T H.248 entities are usually equipped with local clocks, primarily due to economical reasons. However, external time references, based on radio sources (e.g., WWV) or time sources such as satellite-based positioning systems (e.g., GPS, Galileo), may become more and more attractive in case of cost-effective availability of correspondent components.

NOTE – Clause 7.2.4.1 of [ITU-T X.743]: Each source of time information in a real system is considered to be a local clock. A local clock is conceptually the hardware and software that constitutes the source of time information in the system. A functioning local clock is one in which the maximum frequency error of the clock does not exceed the manufacturer's tolerance specified for that clock.

Clock coordination is the collection of protocol mechanisms, procedures and algorithms that are used to exchange time information between individual clocks and to process that information to provide for the coordination of the same clocks. Generally, this coordination takes place between local clocks in different systems using a clock coordination protocol. Clock coordination also takes place between local clocks and external references within a system. See [ITU-T X.743] for more information.

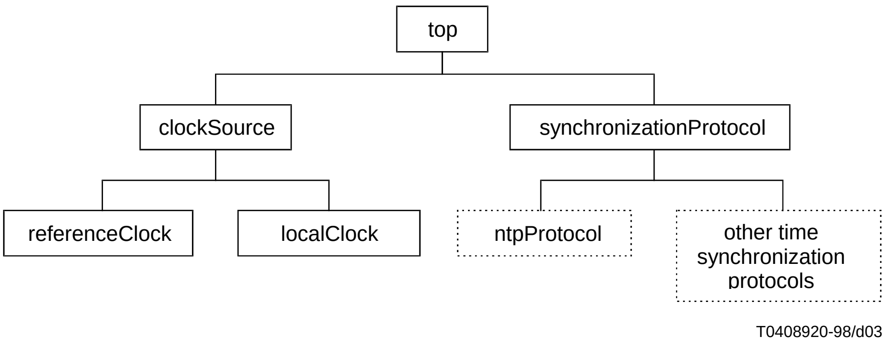

Figure 7 – Objects for clock sources and clock coordination protocols (from Figure 3 of [ITU-T X.743])

9.2 Time synchronization in ITU-T H.248 domains

Different clock coordination functions exist and may be used (clause 7.3 of [ITU-T X.743]). Multiple clock coordination functions can exist in a single ITU-T H.248 entity and ITU-T H.248 domain.

Time synchronization is achieved with a particular protocol (see clause 9.2.1) used to exchange time information between various local clocks of the ITU-T H.248 entities within an ITU-T H.248 domain. Standardized time synchronization protocols shall be used for that purpose.

NOTE – The ITU-T H.248 protocol itself is not designed for the purpose of time synchronization between ITU-T H.248 entities.

Time synchronization could be also achieved via direct external time references (see clause 9.2.2).

9.2.1 Time synchronization protocol

The time synchronization protocol is used to exchange time information between systems for the purposes of synchronization. Currently, there is a number of current time synchronization protocols, e.g.:

1) network time protocol (NTP) Version 3 (NTPv3, [IETF RFC 1305]); or
2) simple NTP (SNTP) Version 4 (SNTPv3, [IETF RFC 4330]); or
3) distributed time service (DTS, see [ITU-T X.743]); or
4) probabilistic clock synchronization (PCS, see [ITU-T X.743]).

NOTE – The time synchronization procedure with time synchronization protocols with rather long convergence times should be already started (if possible) before the ITU-T H.248 control association establishment procedures are triggered.

9.2.2 Direct external time references

Global navigation satellite systems distribute time signals, which are suited for use as external time references for ITU-T H.248 entities. There are a number of such navigation systems, e.g.:

1) global positioning system (GPS);
2) Galileo positioning system;
3) GLONASS;
4) DORIS.

An ITU-T H.248 entity may be equipped with a correspondent receiver unit for such time signals, calculate the precise time and use that information as reference time for the local clock.

9.3 Structures of time synchronization subnet

This clause provides sample synchronization structures for ITU-T H.248 domains. Clause 9.3.1 illustrates a generic principle for ITU-T H.248 domains; and the following clauses show synchronization structures, either with time synchronization protocols or direct external time references.

9.3.1 Synchronization structures – Basic principle for ITU-T H.248 domains

The principal time alignment in case of ITU-T H.248 entities is hierarchical and recalled again in Figure 8 on the left side. That hierarchy may be resolved, using instead direct interfaces between ITU-T H.248 entities and one or more time servers (see Figure 8, right side).

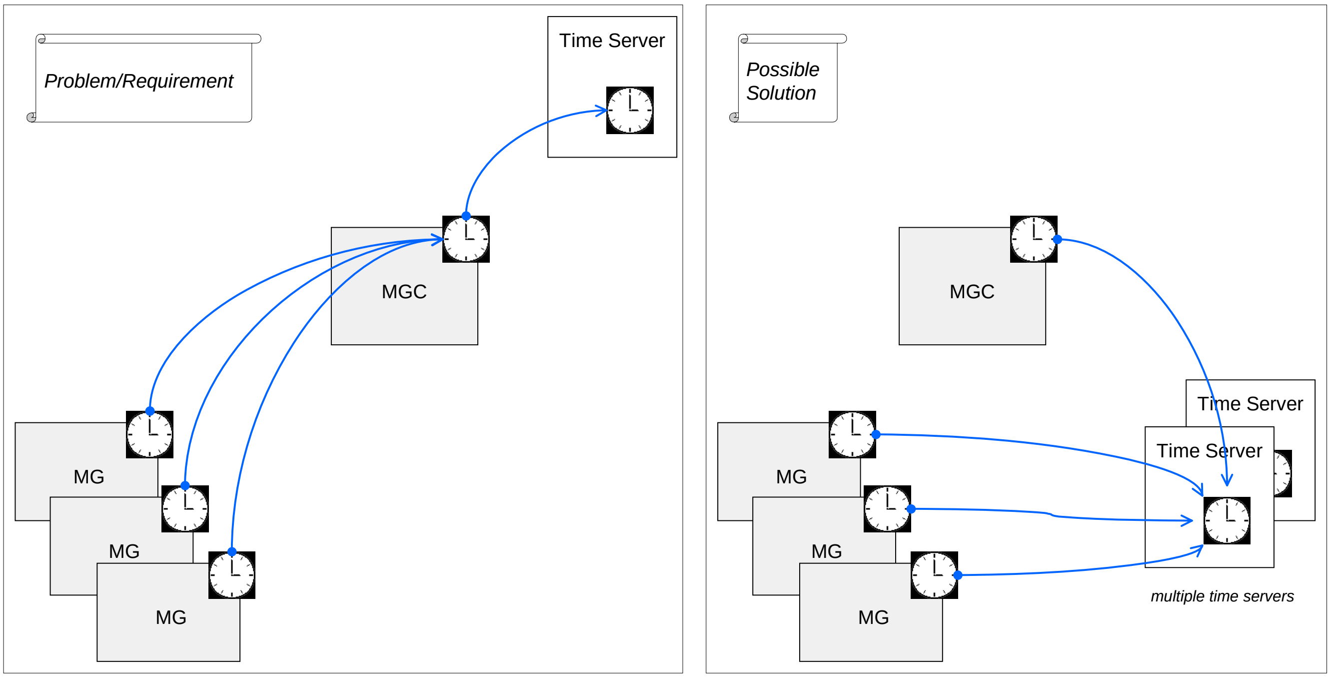

Figure 8 – Synchronization structures – Basic principle for ITU-T H.248 domains

The interface between the ITU-T H.248 entity and a time server entity uses either a time synchronization protocol (see clause 9.3.2), or a direct external time reference (see clause 9.3.3).

9.3.2 Synchronization structures with time synchronization protocols

NTP is a possible technology for time synchronization in IP-based networks. Figure 9 shows a possible synchronization structure with NTP. Every ITU-T H.248 entity provides the NTP client function and is subscribed to one or more (secondary) NTP time servers. All ITU-T H.248 entities of the same ITU-T H.248 domain should use the same time servers.

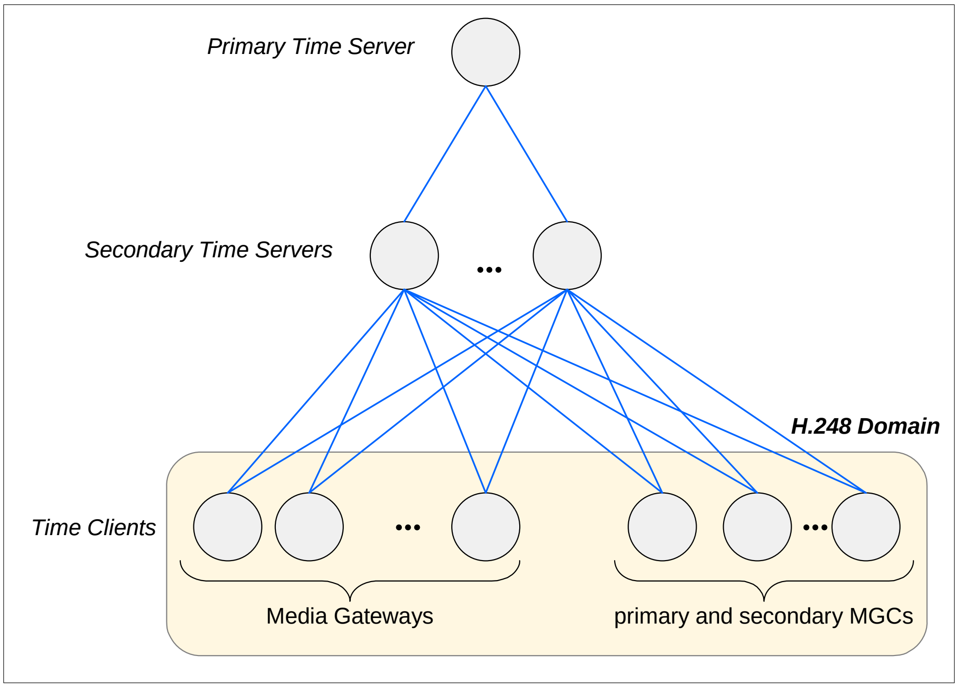

Figure 9 – Structure of time synchronization subnet in case of NTP

The secondary time servers are connected to a primary time server, which uses, e.g., a calibrated atomic oscillator (e.g., cesium clock standards) as clock reference.

9.3.2.1 Limitations of NTP

NTP is related to IP, and might be therefore inappropriate for ITU-T H.248 entities in non-IP environments.

9.3.3 Synchronization structures with direct external time references

The ITU-T H.248 entities are indirectly connected to a clock reference in clause 9.3.2. Other possibilities are direct interfaces to external time references. Figure 10 shows the resulting logical synchronization structure in case of GPS.

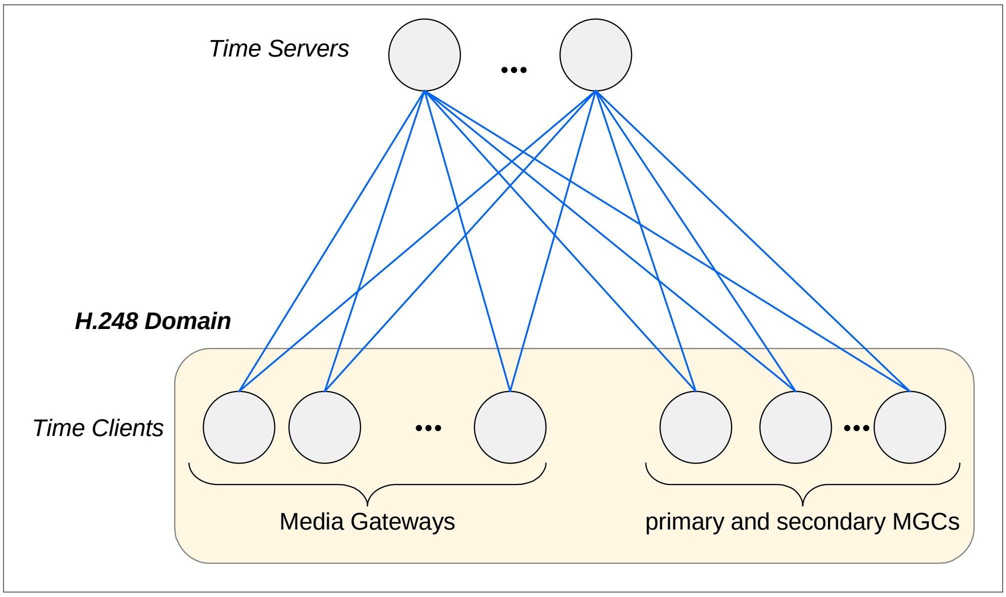

Figure 10 – Structure of time synchronization subnet in case of GPS

The time clients in the ITU-T H.248 entities would be related to a GPS receiver. Each GPS sender provides an embedded calibrated atomic clock.

9.3.4 Synchronization structures with transmission layer based time references

Synchronous and plesiochronous digital transmission requires clock synchronization across the involved network elements. Such a clock may be distributed via a separate, dedicated clock distribution network, or the synchronous transmission network itself, or using specific methods defined for packet networks as mentioned in clause 1.1.1.

A local clock in an ITU-T H.248 entity is driven by a local oscillator, which may take into account above transmission layer based clock signals in addition. Any reliable transmission layer clock signal may help to minimize drift of the local clock, but may not replace the service of a time synchronization protocol or a direct external time reference.

This is mainly because today's transmission layer technologies do not support correction of leap seconds, adaptation to local time zones or daylight saving time, or (at all) the time offset between the clock's reading and UTC (see clause 3.1.8).

However, it should be noted that ITU-T H.248 entities may benefit in the future from time references based on a further evolved transmission layer.

9.4 ITU-T H.248 time domain distributed over multiple time zones

Multiple time zones can be served with a single time reference. The ITU-T H.248 entities *may* then add a local offset, dependent on the time zone of their location. This is a configuration management aspect, and depends finally on the requirements of the served user of the time information (e.g., MGC, management system, billing server, etc.).

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