A.1.1 Timestamping and Time Synchronization

Timestamps associated with observations sent over the Continua WAN shall be referenced to a single consistent Coordinated Universal Time (UTC) timeline to facilitate accurate correlation and processing. Ideally the timestamps should include the local time offset where the observations were made to facilitate correlation with manual records maintained by the patient and caregivers.

Since many PAN and LAN Devices have only a sense of internal time, and this internal time may not be equivalent to the UTC and local time maintained by the AHD, the Continua WAN interface requires the ability to report a **coincident timestamp pair**. The coincident timestamp pair is formed by capturing the current time from both the device and the AHD as close to simultaneously as is reasonably possible. This establishes the time relationship between the AHD and the device's internal time and allows the AHD to report device observations on the UTC timeline.

Note: The coincident timestamp pair allows the WAN receiver to display and record the original device time, the AHD UTC time (or both). The coincident timestamp pair can also support an audit of the original timestamps provided by the PAN or LAN Device.

Definitions:

qualified time: A "qualified time" expresses a unique time point along the Coordinated Universal Time (UTC) timescale that is the primary time standard by which the world regulates clocks and time.

Qualified time is expressed as an HL7 V2 "DTM" datatype and must include the time zone offset, expressed either as ±ZZZZ (HHMM) if the civil time zone offset is known or -0000 if UTC time (e.g. derived from NTP) is known but the actual civil time zone offset is not.

YYYYMMDDHHMMSS[.S[S[S[S]]]]**±ZZZZ** if civil time zone offset ±ZZZZ is known

YYYYMMDDHHMMSS[.S[S[S[S]]]]**-0000** if UTC time is known but civil time zone is not

Examples:

Example	Description
|19760104010123-0500|	1:01:23 AM on January 4, 1976 in the Eastern Standard Time zone (USA)
|19760704010123-0400|	1:01:23 AM on July 4, 1976 in the Eastern Daylight Saving Time zone (USA).
|19760704010523-**0000**|	1:01:23 AM on July 4, 1976, Eastern Daylight Saving Time, expressed as UTC.
|20130722162400+0100|	4:24:00 PM on July 22, 2013, British Summer Time (BST) (Prince George birth)
|20131122162400+0000|	4:24:00 PM on November 22, 2013, Greenwich Mean Time (GMT)
|20131122162400-**0000**|	4:24:00 PM on November 22, 2013 in London, but expressed as UTC.
|20131123012400+0900|	The same time-point, expressed with Tokyo local time-zone offset (on the next day)

unqualified local time: **YYYYMMDDHHMMSS**[.S[S[S[S]]]] time zone offset is omitted: the civil time zone offset and UTC time are both unknown

synchronized: a qualified timestamp that has been "recently" synchronized to a reference time source such as NTP.

DTM$_{AHD}$: HL7 V2 'DTM' timestamps sent by the AHD in **MSH-7**, **OBR-7**, **OBR-8** and **OBX-14**. These represent the time that will be used by the WAN receiver and other enterprise applications.

To ensure the highest level of interoperability, it is **strongly recommended** that **DTM$_{AHD}$** timestamps use **qualified time** to express a unique timepoint on the UTC timescale. Ideally, the actual civil time zone offset ±ZZZZ **should** be used; otherwise, the time zone -0000 may be specified to indicate UTC

time. Furthermore, the AHD **shall** be capable of being synchronized to a reference time source such as NTP, CDMA, GSM NITZ or other source of reference time. In certain cases (and only as a last resort) unqualified local time may be conveyed by a DTM_{AHD} timestamp.[1]

A.1.1.1 AHD Clock and Synchronization

Information regarding the AHD clock and AHD synchronization state are described in Table 1. By convention, information describing the AHD clock is conveyed by MDS level 0 in OBX-4.

Table 1 AHD Time Elements

Msg Segment	Description and comments	Q[2]
MSH.....	**MSH-7** Date/Time of Message created/sent (DTM_{AHD})	M
PID.....		M
OBR.....	[**OBR-7**, **OBR-8**) Default time interval for child OBXs (DTM_{AHD})	M
OBX.. 0	AHD	M
OBX.. 0.0.0.1[3]	MDC_TIME_SYNC_PROTOCOL (OBX-5 specifies the time sync protocol of the AHD; see Table 5 for the list of valid synchronization profiles)	M
OBX.. 0.0.0.2	MDC_TIME_SYNC_ACCURACY (OBX-5 specifies the known or estimated accuracy of DTM_{AHD} time, relative to a reference time source such as NTP)	O
OBX.. 0.0.0.3	MDC_ATTR_TIME_REL (OBX-5 specifies the relative time stamp value, OBX-14 specifies the corresponding DTM_{AHD}, and OBX-18 specifies the unique identity of the timebase provided by the AHD)	C
OBX.. 0.0.0.4	MDC_TIME_RES_REL (OBX-5 specifies the resolution of the relative clock)	O
OBX.. 0.0.0.5	MDC_ATTR_TIME_REL_HI_RES (OBX-5 specifies the hi-res relative time stamp value, OBX-14 specifies the corresponding DTM_{AHD}, and OBX-18 specifies the unique identity of the timebase provided by the AHD)	C
OBX.. 0.0.0.6	MDC_TIME_REL_HI_RES (OBX-5 specifies the resolution of the hi-res relative clock)	O

The mandatory MDC_TIME_SYNC_PROTOCOL attribute specifies the time sync protocol used by the AHD, drawing from the list of enumerated values listed in Table 5.

The optional MDC_TIME_SYNC_ACCURACY attribute specifies the estimated accuracy of time stamps sent by the AHD. It is defined as the maximum error of the AHD clock relative to a primary reference clock source such as a NTP, cellular, etc., in seconds. The accuracy is encoded as positive decimal number of seconds (e.g. '10.,' '5.,' '0.5,' etc.) using the HL7 V2 'NM' datatype and **shall** include an estimate of the cumulative error due to clock drift since the AHD clock was last synchronized.[4] If MDC_TIME_SYNC_ACCURACY is unknown or exceeds five minutes, MDC_TIME_SYNC_PROTOCOL **shall** be set to MDC_TIME_SYNC_NONE to indicate an uncalibrated and unsynchronized local clock.

If the AHD provides a common relative or high-resolution relative clock service to devices, it **shall** include MDC_ATTR_TIME_REL or MDC_ATTR_TIME_REL_HI_RES attribute containing a unique identifier string in OBX-18, described in Table 4. If the time synchronization between the

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[1] It is likely that the use of unqualified local time for DTM_{AHD} will be deprecated in the future.
[2] Presence Qualifier, M: mandatory, O: option, C: conditional.
[3] The dotted numbers represent the object hierachy value of OBX-4 and are provided as example values only, except for MDS level 0 which is reserved for observations about the AHD itself.
[4] The accuracy of AHD clocks that are synchronized by the Internet 'Network Time Protocol' (RFC-1305) or 'Simple Network Time Protocol' (RFC-2030) can be estimated using the following relationship: MDC_TIME_SYNC_ACCURACY = 'root dispersion' + ½ 'root delay' + the cumulative clock drift (typically 20 ppm times the elapsed time since the AHD had last synchronized to NTP). Alternative estimates for accuracy may be used if other synchronization protocols or methods are employed. MDC_TIME_SYNC_ACCURACY shall not be reported, however, if the AHD's clock has not been synchronized to a reference source of time.

relative or high-resolution relative clock reported in OBX-5 is known relative to UTC, it shall be disclosed in OBX-14 (this is an example of a coincident timestamp pair). The MDC_TIME_RES_REL and MDC_TIME_REL_HI_RES attributes specify the resolution of the relative and hi-res relative clocks, respectively; if omitted, the default resolution of 125 μs and 1 μs shall be assumed.

A.1.1.2 Device Clocks and Synchronization

Information regarding the device clocks and device observations are described in Table 2.

This information is provided for each device (MDS) and is conveyed at VMD level 0 in OBX-4, prior to any device observations. There are three cases to consider: the first where the AHD translates the original device timestamps to the UTC timeline; the second, where the original device absolute or base-offset timestamps are reported without translation; and third, the device does not communicate a timestamp and the AHD provides timestamps on its behalf.

Case 1: AHD translates device timestamps

The presence of ***any*** MDC_ATTR_TIME_ { ABS, BO, REL and REL_HI_RES } attribute within the containment scope of the MDS level OBX for the device indicates that the AHD has translated the original device timestamps to the UTC or local timeline. The attribute(s) convey the coincident pair of the device timestamp in OBX-5 and the corresponding DTM_{AHD} in OBX-14.

This allows the AHD to report device observations on the UTC timeline and documents the device to DTM_{AHD} conversions for auditing purposes. This information may be used by the WAN receiver to reconstruct the original device time, assuming that discontinuities do not exist in the original device timeline.

The MDC_TIME_RES_REL and MDC_TIME_RES_REL_HI_RES specify the resolution of the relative and hi-res relative clocks, respectively. If these attributes are omitted, the default resolution of 125 μs and 1 μs shall be assumed.

The default time interval for all measurements is specified by [OBR-7, OBR-8) of the containing OBR message segment. A time that falls within this interval can be explicitly specified by a DTM_{AHD} time point value specified by OBX-14 at the CHAN, METRIC, FACET or SUBFACET levels. Every OBX-14 timestamp value must be within the interval [OBR-7, OBR-8) specified by the containing OBR.

Table 2 Device Time Elements

Msg Segment	Description and Comments	
OBR.....	[OBR-7, OBR-8) Default time interval for child OBXs (DTM_{AHD})	M
OBX.. 1	MDS for device #1	M
OBX.. 1.0.0.1	MDC_TIME_CAP_STATE (BITS-16, using MdsTimeCapState)	C
OBX.. 1.0.0.2	MDC_TIME_SYNC_PROTOCOL (from nom-part-infrastruct)	O
OBX.. 1.0.0.3	MDC_TIME_SYNC_ACCURACY (device absolute or base-offset time accuracy)	O
OBX.. 1.0.0.4	MDC_ATTR_TIME_ABS (OBX-5 specifies the unqualified displayed time and OBX-14 specifies the corresponding DTM_{AHD})	C
OBX.. 1.0.0.5	MDC_ATTR_TIME_BO (OBX-5 specifies the qualified displayed time and time zone offset and OBX-14 specifies the corresponding DTM_{AHD})	
OBX.. 1.0.0.6	MDC_ATTR_TIME_REL (OBX-5 specifies the relative time stamp value, OBX-14 specifies the corresponding DTM_{AHD}, and OBX-18, if present, specifies the unique identity of the timebase)	
OBX.. 1.0.0.7	MDC_TIME_RES_REL (OBX-5 specifies the resolution of the relative clock and OBX-18, if present, specifies the unique identity of the timebase)	
OBX.. 1.0.0.8	MDC_ATTR_TIME_REL_HI_RES (OBX-5 specifies the hi-res relative time stamp value, OBX-14 specifies the corresponding DTM_{AHD}, and OBX-18, if present, specifies the unique identity of the timebase)	

	OBX.. 1.0.0.9	MDC_TIME_RES_REL_HI_RES (OBX-5 specifies the resolution of the hi-res relative clock, and OBX-18, if present, specifies the unique identity of the timebase)	
	OBX.. 1.0.N.M	For any observation, OBX-14 DTM_{AHD} may be *optional*ly valued with a timepoint that overrides the default (OBR-7, OBR-8] time interval of the containing OBR	
	OBR.....	[OBR-7, OBR-8) Default time interval for child OBXs (DTM_{AHD})	O
	OBX.. 2	MDS for device #2	M

Notes for Table 2:

a. The conversion of device time to DTM_{AHD} may introduce a rounding error of the fractional component due to the conversion of the original binary fractional component expressed in units of $1/65536^{th}$ of a second to a decimal fraction that is limited to $1/10000^{th}$ of a second

b. Within the time scope of each MDS object, time discontinuities in the MDC_ATTR_TIME_ABS *displayed time* are prohibited. Discontinuities due to daylight savings or other clock adjustments require data on the new displayed timeline be sent under a separate MDS or within a separate message. Since the Base component of the Base Offset time is never discontinuous by definition, any discontinuity is expressed by the offset ±ZZZZ. Thus the AHD will not have a problem providing a consistent time base in OBX-14 and it is not necessary to perform the above steps when the offset value changes.

c. OBR-7 and OBR-8 establish the default time context for all OBXs within the scope of the containing OBR. If only OBR-7 is specified, the default time context is a time point; if OBR-7 and OBR-8 are both specified, it is a time interval. The default time context can be overridden by a timestamp (representing a point in time) in OBX-14 at the CHAN, METRIC, FACET or SUBFACET levels.

d. The time interval specified by [OBR-7, OBR-8) is a mathematically 'closed' interval for OBR-7 and 'open' for OBR-8. A datum that occurs exactly at the time specified by OBR-8 would be sent in the next time epoch. This allows subsequent OBR segments to represent a continuous sequence of time. For encoding a simple set of episodic measurement, if there is no logical "end" of the observation period, OBR-8 can be set to the message creation time as a logical upper limit for the contained observations

Case 2: AHD does not translate device timestamps

If ***none*** of the MDC_ATTR_TIME_ { ABS, BO, REL and REL_HI_RES } attributes are present, the original absolute (ABS) device time is reported in OBX-14 as an 'unqualified local time' (without a time zone offset) or the original base-offset (BO) device time is reported in OBX-14 as a 'qualified time' having a ±ZZZZ or -0000 time zone offset.

This allows the AHD to report the original device timestamps in cases where (1) the device's qualified base-offset timestamps are presumed to be more accurate than the AHD's or (2) where it is impossible for the AHD to calculate a trustworthy UTC time from an unqualified local device time.

Case 3: AHD provides timestamp on behalf of device

The disclosure of MDC_TIME_CAP_STATE with *all* of the following MdsTimeCapState bits:

mds-time-capab-real-time-clock(**0**),
mds-time-capab-relative-time(**2**),
mds-time-capab-high-res-relative-time(**3**),
mds-time-capab-bo-time(**7**),

in the cleared (to zero) state indicates that the device was not capable of providing timestamps and that the OBX-14 timestamps in subsequent OBXs were provided by the AHD on behalf of the device.

A.1.1.3 AHD and Device Timestamps

Table 3 shows how device timestamps may (or may not) be converted to the UTC timeline, given the (1) AHD clock capability, (2) the type of device timestamp and (3) whether a coincident timestamp pair is (or was) associated with the device observation. The symbol 'T(*)' indicates that the device time '*' can be translated to the UTC timeline, and assumes that the coincident timestamp pair exists and is disclosed using the MDC_ATTR_TIME_ { ABS, BO, REL and REL_HI_RES } attribute(s). The symbol '*' indicates the original device time may be reported. Additional information such as AHD and device synchronization state and accuracy can be used if a choice between T(*) and * is permitted.

Table 3 AHD and Device Timestamps

Case	AHD Clock and Timestamps				Device Timestamps		
	NTP	**Local**	**DST**	**TZ**	**Hi-res/Relative**	**Absolute** (no TZ)	**Base-Offset** (±TZ)
A	Yes	Yes	Yes	±ZZZZ	T(*)±ZZZZ	T(*)±ZZZZ else *	*±ZZZZ or T(*)±ZZZZ
B	Yes	Yes	No	±ZZZZ	T(*)±ZZZZ	T(*)±ZZZZ else *	*±ZZZZ or T(*)±ZZZZ
C	Yes	No	No	-0000	T(*)-0000	T(*)-0000 else *	*±ZZZZ or T(*)-0000
D	No	Yes	No	±ZZZZ	T(*)±ZZZZ	T(*)±ZZZZ else *	*±ZZZZ or T(*)±ZZZZ
E	No	No	No	none	T(*)	*	*±ZZZZ

Case	AHD Time Description	Qualified	Error
A	Best: Displayed time and time zone known (by DST rules)	Yes	< 1 sec
B	Better: Displayed time and time zone known (by external information)	Yes	< 1 sec
C	Good: UTC time known but displayed time and zone unknown	Yes	< 1 sec
D	Usable: Qualified time but not synchronized (e.g. manually set by user)	Yes	< 120 sec
E	Poor: Unqualified and unsynchronized local time (UTC and TZ unknown)	No	≈ 1 hour

Column Definitions for AHD Clock and Timestamp Properties:

Case is a label for each combination of **AHD Clock and Timestamp** properties, including:

NTP: 'Yes' if synchronized to global time reference such as NTP, CDMA, GSM NITZ, … , 'No' if not.

Local: 'Yes' if current local time zone offset is known, 'No' if not.

DST: 'Yes' if aware of local Daylight Savings Time rules, 'No' if not.

TZ: ±ZZZZ if civil time zone offset known, -0000 if only UTC time is known, 'none' if unknown.

Qualified: 'Yes' if "qualified" by having a ±ZZZZ or -0000 time zone offset.

Error: Nominal error (e.g. "unqualified local time will be incorrect for 23 out of 24 time zones")

Column Definitions for Device Timestamps:

1. **T(*)** refers to **translated device timestamps**, indicated by presence of any of the following attributes under the MDS-level OBX for a device:

MDC_ATTR_TIME_REL	Relative Time (default 125 µs resolution counter)
MDC_ATTR_TIME_REL_HI_RES	Hi-res Relative Time (default 1 µs resolution counter)
MDC_ATTR_TIME_ABS	Absolute Time: eight pairs of 4-bit BCD nibbles denoting { century, year, month, day, hour, minute, second, sec-fractions }, no time zone.
MDC_ATTR_TIME_BO	Base Offset Time: NTP 32 seconds:16 fraction-seconds and signed 16-bit time-zone offset (in minutes)

2. ***** indicates an **original device timestamp**, indicated by the absence of any of the MDC_ATTR_TIME_* attributes noted above.
3. **±ZZZZ** indicates time-zone offset, **-0000** indicates UTC / NTP time, no suffix after T(*) or * indicates "local" time.
4. XXX **else** YYY indicates XXX preferred over YYY; XXX **or** YYY indicates no preference.

Notes (informative):

1. For TZ = -0000, the WAN receiver could adjust time zone based on 'local agreement' without loss of accuracy.
2. If AHD is used in a known or restricted geographic area, WAN receiver could adjust time zone based on 'local agreement'.

General Comments (informative)

For the **Hi-res/Relative** device timestamp column, translation T(*) is required to convert the integer count to the AHD UTC timeline.

For the **Absolute** device timestamp column, translation T(*) is required to convert the absolute time to the AHD UTC timeline as well as local time with timezone offset. The transformation can only be performed if a concident timestamp pair was captured and does not have any discontinuities due to Daylight Savings or other adjustments during the time interval (OBR-7, OBR-8] since T(*) is a linear transformation. If this condition cannot be guaranteed it is recommended that the original unqualified local timestamp '*' be sent instead.

For the **Base-Offset** device timestamp column, the original *±ZZZZ or translated T(*)±ZZZZ timestamp may be sent, with a preference for the former unless it was necessary for the AHD to correct for device clock drift.

For an **AHD clock that is unsynchronized and is unaware of local time** (row/Case E), an **absolute** device time shall be sent as an unqualified '*' timestamp, a **base-offset** device time shall be sent as a qualified *±ZZZZ timestamp with no correction applied, and a **hi-res/relative** time shall be translated and sent as an unqualified T(*) timestamp.

Additional AHD and Device Timestamp Selection Rules

The previous table indicates a choice between using the AHD translated time T(*) and the original device time * for certain combinations of AHD and device timestamps. This section provides further guidance regarding the selection, based on the whether the AHD and/or device time is synchronized, and in the case where both are synchronized, their relative synchronization accuracy (if known).

AHD		T(*)	*Next ⇨*
	sync'd	T(*)	*Next ⇨*
	not sync'd	*	*
		not sync'd	sync'd
		Device	

AHD Accy		T(*)	*Use Best*
	known	T(*)	*Use Best*
	unknown	*	*
		not sync'd	sync'd
		Device Accy	

Notes: *Next ⇨* Use to table to right to make final determination.

Use Best Use T(*) if AHD Accy is better than Device Accy; else use *.

A.1.1.4 HL7 Timebase Identifier

For this purpose, this document defines the following HL7 User Table for OBX-18-2: Namespace ID.

Table 4 HL7 User Table for OBX-18-2

OBX-18-2	Description	Examples
TIMEBASE_ID	A universally unique identifier of the timebase used for a given relative timestamp	732d2650-2cd1-11df-8a39-0800200c9a66^TIMEBASE_ID BT_HDP-ABCDEF123456-1^TIMEBASE_ID[5]

Two relative or high-resolution relative observations are 'comparable' if and only if the OBX-18 values match exactly.

A.1.1.5 Synchronization Protocols

Beyond the use of the MDC_ATTR_TIME_ABS, MDC_ATTR_TIME_BO, MDC_ATTR_TIME_REL, and MDC_ATTR_TIME_REL_HI_RES time code observations, a WAN Observation Sender **may** provide additional information about the PAN or LAN Device clocks by communicating the MDC_TIME_SYNC_PROTOCOL of a given device. Valid synchronization profiles are shown in Table 5.

Table 5 Valid Synchronization Profiles

OBX-5	Synchronization Protocol	Part::Code
532224^MDC_TIME_SYNC_NONE^MDC	An uncalibrated and unsynchronized local clock source[6]	8::7936
532234^MDC_TIME_SYNC_EBWW^MDC	A manually set time, by 'eyeball and wristwatch'	8::7946
532225^MDC_TIME_SYNC_NTPV3^MDC	Network Time Protocol Version 3.0 (RFC 1305)	8::7937
532226^MDC_TIME_SYNC_NTPV4^MDC	Network Time Protocol Version 4.0 (under dev)	8::7938
532227^MDC_TIME_SYNC_SNTPV4^MDC	Simple Network Time Protocol v4 (RFC 2030)	8::7939
532228^MDC_TIME_SYNC_SNTPV4330^MDC	Simple Network Time Protocol v4 (RFC 4330)	8::7940
532229^MDC_TIME_SYNC_BTV1^MDC	Bluetooth Medical Device Profile	8::7941
532235^MDC_TIME_SYNC_USB_SOF^MDC	Synced to the 1kHz USB "start-of-frame" clock	8::7947
532230^MDC_TIME_SYNC_RADIO^MDC	Atomic Clock synchronization through RF	8::7942
532231^MDC_TIME_SYNC_HL7_NCK^MDC	Synchronized via Health Level 7 NCK (network clock)	8::7943
532232^MDC_TIME_SYNC_CDMA^MDC	CDMA mobile telecommunications synchronization	8::7944
532233^MDC_TIME_SYNC_GSM^MDC	GSM - Network Identity and Time Zone (NITZ)	8::7945

[5] One suggested approach for defining this unique identifier is to use the 3-tuple of the synchronization protocol, an identifier for the synchronization source (eg. a bluetooth address), and the 'epoch' of this clock (eg. an integer value which increments with each new association, or a datetime signifying the start of the last synchronization).

[6] If MDC_TIME_SYNC_ACCURACY is unknown or exceeds five minutes, MDC_TIME_SYNC_PROTOCOL shall be set to MDC_TIME_SYNC_NONE to indicate an uncalibrated and unsynchronized local clock.

A.1.1.6 Absolute or Base Offset Timestamp Accuracy

Absolute or base-offset timestamp 'accuracy' **may** be reported using MDC_TIME_SYNC_ACCURACY. For instance, if the device's clock has been synchronized using the Internet 'Network Time Protocol' (RFC-1305), 'Simple Network Time Protocol' (RFC-2030), the HL7 v2.4 'NCK' system clock segment, or another sufficiently capable time synchronization protocol, it is possible to compute the possible drift in accuracy since the device's last synchronization[7]. Estimated values for accuracy may be reported in cases where the agent had acquired and stored data while disconnected from a time synchronization source.

If MDC_TIME_SYNC_ACCURACY is unknown or exceeds five minutes, MDC_TIME_SYNC_PROTOCOL shall be set to MDC_TIME_SYNC_NONE to indicate an uncalibrated and unsynchronized local clock.

MDC_TIME_SYNC_ACCURACY **shall not** be reported if the device clock has not been synchronized, as devices may rely on this value to determine whether they should update their own clocks and to qualify the accuracy of their own timestamps. Timestamp accuracy does not include the communication latency between the AHD and the timeserver; it only specifies the known accuracy of the AHD's timestamp relative to a primary reference clock source.[8]

```
OBX|6|DTM|67975^MDC_ATTR_TIME_ABS^MDC|1.0.0.1|20091028123702||||||R|||20091028173702+0000
OBX|7|CWE|68219^MDC_TIME_CAP_STATE^MDC|1.0.0.2|1^mds-time-capab-sync-abs-time(4)~1^mds-time-state-abs-time-synced(8)|||||R
OBX|8|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|1.0.0.3|532228^MDC_TIME_SYNC_SNTPV4330^MDC|||||R
OBX|9|NM|68221^MDC_TIME_SYNC_ACCURACY^MDC|1.0.0.4|1.2|264320^MDC_DIM_SEC^MDC|||||R
```

A.1.1.7 Time Synchronization Examples

Devices using Absolute Time

This example sends a blood pressure observation (systolic, diastolic, and mean arterial pressure) for a patient in Los Angeles taken at 09:10:05 on 8 Jan 2010 from a PAN device which had an internal time of 18:08:26 1 Jan 1900 at 14:03:45 on 4 Jan 2010.

```
MSH|^~\&|AcmeInc^ACDE48234567ABCD^EUI-64||||20090713090030+0000||ORU^R01^ORU_R01|MSGID1234|P|2.6|||NE|AL|||||IHE PCD ORU-R01 2006^HL7^2.16.840.1.113883.9.n.m^HL7
PID|||789567^^^Imaginary Hospital^PI ||Doe^John^Joseph^^^^L^A|||M
OBR|1|AB12345^AcmeAHDInc^ACDE48234567ABCD^EUI-64|CD12345^AcmeAHDInc^ACDE48234567ABCD^EUI-64|182777000^monitoring of patient^SNOMED-CT|||20100108091005+0800
OBX|1|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.1|532224^MDC_TIME_SYNC_NONE^MDC|||||R
OBX|2||528391^MDC_DEV_SPEC_PROFILE_BP^MDC|1|||||||X|||||||0123456789ABCDEF^EUI-64
OBX|3||150020^MDC_PRESS_BLD_NONINV^MDC|1.0.1|||||||X|||20100108091005+0800
OBX|4|DTM|67975^MDC_ATTR_TIME_ABS^MDC|1.0.0.1|19000101140345||||||R|||20100104140345+0800
OBX|5|NM|150021^MDC_PRESS_BLD_NONINV_SYS^MDC|1.0.1.1|120|266016^MDC_DIM_MMHG^MDC|||||R
OBX|6|NM|150022^MDC_PRESS_BLD_NONINV_DIA^MDC|1.0.1.2|80|266016^MDC_DIM_MMHG^MDC|||||R
```

---

[7] NTP timestamp accuracy can be estimated from the NTP variables: *root dispersion* + ½ *root delay* + the cumulative *clock drift* (typically 20 ppm times the elapsed time since the agent had last synchronized to NTP). For other absolute time distribution protocols (e.g., cell phone) other methods might be used (and are currently beyond the scope of this document).

[8] At the time of this writing, IEEE 11073-20601 does not specify a high-resolution time synchronization protocol, such as the 'IEEE:1073:3:2:SNTP' IAS service defined in the informative Annex N of ISO/IEEE 11073-30200-2004. The latter supports the exchange of 48-octet NTP or SNTP messages between a client (DCC) and server (BCC) using the 'expedited' TTP_UData transport service (similarly, NTP and SNTP use a 'best effort' UDP/IP transport over UDP port 123).

OBX|7|NM|150023^MDC_PRESS_BLD_NONINV_MEAN^MDC|1.0.1.3|100|266016^MDC_DIM_MMHG^MDC||||R

Devices using a Bluetooth Clock

The example below shows an AHD that synchronized to an NTP V3 (RFC 1305) time reference using a LAN or WAN connection. The AHD also provides a synchronization clock for Bluetooth devices using its Bluetooth clock and are represented as 64-bit high-resolution relative timestamps with a resolution of 1 µsec. Since the AHD generates the underlying Bluetooth clock, it can correlate the high-resolution relative timestamps with an absolute timestamp if NTP or other reference time is available. The OBXs related to AHD timekeeping are shown below:

```
OBX|1|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.3|532225^MDC_TIME_SYNC_NTPV3^MDC|||||R
OBX|2|NM|68221^MDC_TIME_SYNC_ACCURACY^MDC|0.0.0.4|0.18|264320^MDC_DIM_SEC^MDC|||||R
OBX|3|NM|67984^MDC_ATTR_TIME_STAMP_HI_RES^MDC|0.0.0.5|43567138204032|264339^MDC_DIM_MICRO_SEC^MDC|||||R
|||20091028123702.1362+0000||||ABCDEF123456^TIMEBASE_ID
OBX|4|NM|68224^MDC_ATTR_TIME_REL^MDC|0.0.0.6|1.0|264339^MDC_DIM_MICRO_SEC^MDC|||||R|||||||BT_ABCDEF1234
56_01^TIMEBASE_ID
```

The device indicates that it uses Bluetooth timestamps, with a time synchronization accuracy of 10 µs, relative to the Bluetooth HDP hi-res timestamps, as shown below:

```
OBX|5||528388^MDC_DEV_SPEC_PROFILE_PULS_OXIM^MDC|1|||||||X|...
OBX|6|CWE|68219^MDC_TIME_CAP_STATE^MDC|1.0.0.2||1^mds-time-capab-sync-hi-res-relative-time(6)~1^ mds-
time-state-hi-res-relative-time-synced(10)|||||X
OBX|7|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|1.0.0.3||532229^MDC_TIME_SYNC_BTV1^MDC|||||X
OBX|8|NM|68221^MDC_TIME_SYNC_ACCURACY^MDC|1.0.0.4|10|264339^MDC_DIM_MICRO_SEC^MDC|||||R
OBX|9|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|1.0.0.5|98|262688^MDC_DIM_PERCENT^MDC|||||R
OBX|10|NM|67984^MDC_ATTR_TIME_STAMP_HI_RES^MDC|1.0.0.5.1|132434|264339^MDC_DIM_MICRO_SEC^MDC|||||R|||||||
BT_ABCDEF123456_01^TIMEBASE_ID
OBX|11|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|1.0.0.6|98.1|262688^MDC_DIM_PERCENT^MDC|||||R
OBX|12|NM|67984^MDC_ATTR_TIME_STAMP_HI_RES^MDC|1.0.0.6.1|232802|264339^MDC_DIM_MICRO_SEC^MDC|||||R|||||||
BT_ABCDEF123456_01^TIMEBASE_ID
```