Operator Logo

RAN Network Synchronization

WCDMA RAN

Feature Guide

RAN Network Synchronization Feature Guide

Version	Date	Author	Approved By	Remarks
V4.5	2010-10-15	Qiu WenCai	Zhang Min	Not open to the Third Party

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1 Functional Attributes

System version: [RNC V3.09, Node B V4.09, OMMR V3.09, and OMMB V4.09]

Attribute: [Optional]

Involved NEs:

MS	Node B	RNC	MSC	MGW	SGSN	GGSN	HLR
-	√	√	-	-	-	-	-
Note: *-: Not involved. * √: Involved.							

Dependency: [None]

Mutually exclusive function: [None]

Remarks: [None].

2 Overview

2.1 Function Introduction

According to the 3GPP TS 25.104, the precision of RAN clocks should be higher than ± 0.05 ppm.

In order to meet the requirements in various application scenarios, the RAN supports multiple clock synchronization modes.

The RNC supports the following clock synchronization modes:

1 Extracting clock synchronization signals from the Iu interface

2 Synchronizing to Building Integrated Timing Supply System (BITS) clocks

3 Synchronizing to Global Positioning System (GPS) clocks

The Node B supports the following clock synchronization modes:

1 Extracting clock synchronization signals from the Iub interface

2 Synchronizing to Building Integrated Timing Supply System (BITS) clocks

3 Synchronizing to Global Positioning System (GPS) clocks

4 Synchronizing to IEEE 1588 clocks

5 Synchronizing to Synchronous Ethernet (SyncE) clocks

When E1/T1/STM-1 transmission is used on the Iub interface, the clocks extracted from the Iub interface are recommended as synchronization clocks. When FE/GE transmission is used on the Iub interface and BITS clocks can be provided, the BITS clocks are recommended as synchronization clocks. If FE/GE transmission is used on the Iub interface and BITS clocks cannot be provided, GPS clocks are recommended as synchronization clocks. If it is difficult to install the GPS, IEEE 1588 clocks can be used as synchronization clocks. The smaller the *Priority* value of the clock reference source, the higher the clock priority.

ZTE RNC supports at most seven external reference clocks: two 2M BITS clocks, two 2M clocks, and three 8K clocks extracted from the line. Whether to use clock references (*Enable/Disable Clock Reference*), which clock references to use (*Clock reference allowing board switch*) and the master clock reference (*Master Clock Reference*) can all be set through the OMC. When the external 2 Mbits or 2 MHz clock reference source is used, the clock impedance (*Clock input impedance*) needs to be configured according to the actual situation. ZTE Node B supports at most seven external reference clocks: two clocks extracted from the Iub interface, two BITS clocks, one GPS clock, one IEEE 1588 clock, and one SyncE clock. The reference clocks of the Node B can also be configured through the OMC. A priority is assigned to each reference clock. The system can select the clock with the highest priority from a group of available reference clocks as the reference clock.

When the reference clock is lost, the RNC can working in two behavior depending on the *Class 2 clock base missing behavior*. The one behavior is switches to the holdover state. RNC can maintain the normal system services for at least 48 hours. Then the *Master Clock Reference* can be manually modified to select another available clock as the reference clock. When the reference clock is recovered, the RNC performs clock synchronization again. The synchronization takes about 5 to 6 minutes. The another behavior is automatically switches to the available backup reference clock. When the main reference clock is recovered, the RNC can manually select and synchronizes to the main reference clock again.

When the reference clock is lost, the Node B automatically switches to the next available reference clock. If all the reference clocks are unavailable, the Node B switches to the holdover state. Since the Node B uses the high-precision OCXO as the internal clock, the Node B can maintain the normal system services for at least 90 days. When the configured higher priority reference clock is recovered, the Node B synchronizes to the reference clock again. The time taken for synchronization varies with different reference clocks. In general, it takes about 5 to 6 minutes to synchronize to clocks extracted from the Iub interface or BITS or SyncE clocks(depending on the status of the transmission network), 5 to 15 minutes to synchronize to GPS clocks(depending on the status of GPS and the GPS lost duration), and 20 to 210 minutes to synchronize to IEEE 1588 clocks (depending on the status of the transmission network).

2.1.1 Synchronization via Wireline

The RNC/NodeB can use the BITS as the external clock reference source. When the electrical interface characteristics of the BITS clock conform to ITU G.703, the RNC/NodeB can correctly detect the BITS clock. When the quality of the BITS clock conforms to ITU G.812, the RNC/NodeB can normally trace the BITS clock. The RNC/NodeB supports 2048 kHz, 2048 kbps, and 1544 kbps BITS reference inputs.

The RNC can also extract and trace line clocks from service interfaces providing synchronous timing information. These interfaces include E1, T1, STM-1, and POS interfaces.

The Node B can also extract and trace line clocks from the Iub interface providing synchronous timing information. The line clocks can be extracted from E1, T1, or STM-1 links.

The timing information output from these service interfaces should meet the synchronization interface requirements given in ITU G.823/G.824.

The Node B can also output 2.048 Mbps clock signals via E1 interfaces. The clock conforms to ITU-T G.703 and is provided as a clock reference to the other Node Bs, BTSs, or other equipment located in the same site.

2.1.2 GPS Clock

The RNC supports GPS clock synchronization. It uses the ICM_C board equipped with a GPS receiver. When the GPS clock is used for clock synchronization, a GPS antenna, a GPS lightning arrester, and a feeder need to be installed. GPS clock signals are input from the SMA connector on the front panel of the ICM_C board.

The Node B supports GPS clock synchronization. A GPS receiver is built in the CC board. When the GPS clock is used for clock synchronization, a GPS antenna, a GPS lightning arrester, and a feeder need to be installed. GPS clock signals are input from the SMA connector on the front panel of the CC board.

The installation position of the GPS antenna and the length of the feeder are determined during site engineering survey.

2.1.3 IEEE 1588 Clock

IEEE 1588 clocks can be used for clock synchronization when FE or GE transmission is used on the Iub interface. The IEEE 1588 clock synchronization has two type of function: frequency synchronization and phase synchronization. Currently, RAN is only need frequency synchronization according to RAN requirement. Unless otherwise stated, the IEEE 1588 clock synchronization in this document is frequency synchronization. The IEEE 1588 clock synchronization function is completed by the RNC and the Node B together. The RNC serves as the Master that provides exact clock information. The

Node B serves as the Slave that extracts clock information and performs clock synchronization.

The *SyncSvrAddr*, *IPID*, and *QoS* used by each Node B should be uniformly planned during network planning.

2.1.4 Synchronous Ethernet Clock

SyncE is short for Synchronous Ethernet. SyncE clocks can be used for clock synchronization when FE or GE transmission is used on the Iub interface and the bearer network is Synchronous Ethernet. Synchronous Ethernet is different from normally Ethernet, the clock of Synchronous Ethernet is synchronous and the clock of normally Ethernet is asynchronous. The clocks of all the nodes in Synchronous Ethernet are synchronous. RNC can provide clock by SyncE and the Node Bs can extracts clock from SyncE.

2.1.5 Time synchronization via SNTP for RNC

NTP protocol is applied to synchronize time among these processors inner RNC and other devices of external OMCR.OMM server act as a NTP client which acquires time from upper NTP server. On the other hand, it provides service of time synchronization to RNC as the server of SNTP. As a NTP client, The time synchronization process can be initiated automatically, and it can be initiated manually also.

2.1.6 Time synchronization via SNTP for NodeB

NTP protocol is applied to synchronize time among these processors inner NodeB and other devices of external OMCR.OMM server provides service of time synchronization to NodeB as the server of SNTP. As a NTP client, The time synchronization process can be initiated automatically, and it can be initiated manually also.

3 Technical Description

3.1 Synchronization via Wireline

The Node B supports two line clocks extracted from the Iub interface: Line clock and line other clock. The line clock is extracted from E1/T1 links on the Iub interface, whereas the line other clock is extracted from STM-1 links on the Iub interface. When a link on the Iub interface fails, the Node B automatically switches to another link to extract the clock. This is called clock redundancy backup. For example, suppose the Node B is connected via four E1 links on the Iub interface to the RNC. When the first E1 link fails, the Node B automatically switches to the second E1 link to extract clock signals. When the first E1 link is recovered, the Node B automatically switches back to the first E1 link to extract clock signals.

The Node B can be connected via any E1/T1 links on Iub interface to the RNC. When configuring line clock as clock reference, the Node B automatically selects an E1/T1 link to extract clock signals according to E1/T1 link number from smaller to bigger. For example, suppose the Node B is connected via the E1 link2, link4 and link5 on the Iub interface to the RNC, at first the Node B selects E1 link2 to extract clock signals. When the E1 link2 fails, the Node B automatically switches to the E1 link4 to extract clock signals. When the E1 link2 is recovered, the Node B automatically switches back to the E1 link2 to extract clock signals.

The Node B can also output 2.048 Mbps clock signals via E1 interfaces. The clock conforms to ITU-T G.703 and is provided as a clock reference to the other Node Bs, BTSs, or other equipment located in the same site as the Node B.

The Node B supports BITS clock synchronization. It supports two BITS clocks: 2 MHz BITS clock and 2 Mbps BITS clock. The physical layer of the 2 MHz BITS clock should conform to the T12 interface requirements given in chapter 13 in ITU-T G.703. The 2 MHz BITS clock is input from the SMA connector on the front panel of the CC board. The physical layer of the 2 Mbps BITS clock should meet the E12 interface requirements in chapter 9 in ITU-T G.703. The 2 Mbps BITS clock is input from the receiving end of the eighth E1.

Due to the limited space of the CC board panel, the 2 MHz BITS interface and the GPS interface share the same physical interface, that is, the 2 MHz BITS clock and the GPS clock are mutually exclusive. Only one of them can be selected. Whether to use the interface as the 2 MHz BITS clock interface or as the GPS interface is indicated by the board BOM and determined before the shipment.

The 2 Mbps BITS clock interface and the eighth E1 interface share the same physical interface, that is, the 2 Mbps BITS clock interface and the eighth E1 interface are mutually exclusive. Only one of the two can be selected and determined during the site configuration.

The precision of BITS clocks is higher than ± 0.05 ppm. The jitter and wander of BITS clocks should meet the synchronization interface requirements given in ITU-T G.823.

The *ClockID* of the E1/T1 clock reference source is 6, and that of the STM-1 clock reference source is 7.

The *ClockID* of the 2 MHz BITS clock reference source is 4, and that of the 2 Mbps BITS clock reference source is 5.

3.2 GPS Clock Synchronization

3.2.1 Principles of GPS

GPS is short for the Navigation Satellite Timing and Ranging/Global Positioning System (NAVSTAR/GPS). Developed by the US Department of Defense, the GPS consists of 21 working satellites and 3 on-orbit standby satellites. The 24 satellites are equally spaced on six orbit planes that are 60 degrees to one another, so that at least four GPS satellites can be simultaneously observed at any position on the earth. The GPS is composed of three parts: GPS satellites (space part), the terrestrial support system (terrestrial monitoring part), and GPS receivers (user part).

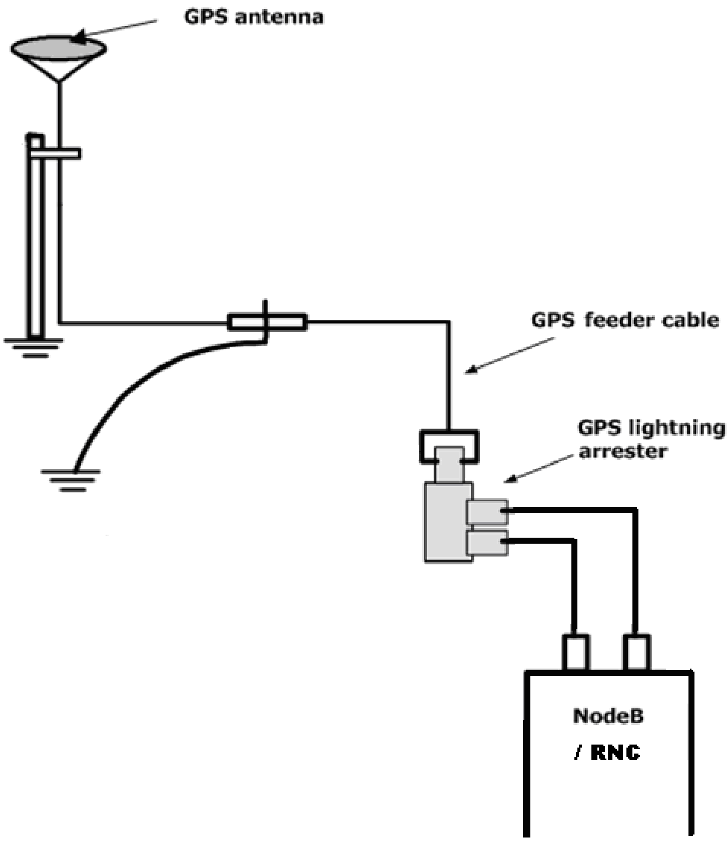
The GPS provides timing and positioning in the global range. GPS users in any place in the world can receive satellite signals through low-cost GPS receivers so as to obtain accurate spatial location information, synchronization references and standard time information. The satellite clocks provided by GPS satellites are compared with the terrestrial master GPS clock reference, so that they are exactly synchronized. The signals of different frequencies sent from GPS satellites come from the same satellite reference frequency. GPS receivers process the signals from GPS satellites and exercise strict error correction for the signals, so that the output signals have very high long-term stability.

The GPS concept is based on satellite ranging. Users measure the distance to a satellite to calculate their own locations. The position of each satellite is already known. A GPS satellite sends location and time signals. A user's GPS receiver measures the time taken for the signals to arrive at the receiver, and thus calculates the distance between the user and the satellite. The satellite receives and interprets the orbit information and time information carried through the returned radio wave, so as to calculate the longitude, latitude, horizontal height, moving speed, and exact time of the GPS receiver. The location of a satellite is fixed for a base station system. During the initial installation and positioning, at least four satellites are needed to exactly determine the longitude, latitude and horizontal height of the GPS receiver and the time offset between the user's clock and the master GPS clock. As long as the system can normally receive signals from one satellite during the running, the system can output 1PPS reference signals with the precision higher than 50 ns. When the compensation algorithm is employed, the precision of the output clock signals is higher than 15 ns and the time is synchronized to the UTC.

GPS satellites are distributed in a space 20200 km above the ground. Therefore, the GPS signals arriving at the ground are very weak. In practical scenarios, different satellites have different elevation angles and the satellite signals are blocked by trees and buildings. For this reason, the GPS signals arriving at the ground may be very weak. The frequency of GPS satellite signals in the L1 band is 1575.42 MHz. Signals within approximately the same band should be avoided nearby the GPS antenna so as to avoid interference to satellite signals.

Figure 3-1 shows a typical application scenario of the GPS, which consists of a GPS antenna, a GPS feeder, a GPS lightning arrester, and a GPS receiver.

Figure 3-1 Typical Application of the GPS



The minimum satellite number requirement is 4 for synchronization on initial power on stage, and on normal operation stage can only need 1 satellite for synchronization.

3.2.2 Node B GPS Clock

The CC board of the Node B supports GPS clock synchronization. The *ClockID* of the GPS clock is 1. To provide this function, the CC board needs to be equipped with a GPS receiver. GPS signals are input from the SMA connector on the front panel of the CC board.

After the CC board is powered on, the CPU initializes the GPS receiver. Initially the GPS receiver can interpret its own geographical location (longitude, latitude and height) and time information only when it can find four or more satellites. Since the location of the GPS receiver is fixed, the GPS receiver will save its own geographical location information. The system can stably output satisfactory clock reference signals as long as the GPS receiver can find at least one satellite later during the normal running. The GPS satellite search results are greatly affected by weather and the environment. The GPS antenna should be installed at a barrier-free position highly above the ground, such as the building rooftop. The space above the GPS antenna should be open. In addition, to achieve a good effect, ensure that no obstacles exist in the range of the elevation angle above 10 degrees.

The faults of the CC board are classified by GPS module faults into class A faults and class B faults.

Class A faults of the GPS module: The 16chip is out of lock or lost, or the 10M output is lost.

Class B faults of the GPS module: The antenna feeder is shorted or disconnected, the satellite searching performance is poor, or no satellite signal can be detected.

The CC board provides the automatic failover function. When the active CC board detects that the fault level of the standby CC board is lower than its own fault level, it automatically initiates active/standby switchover. The fault levels are sorted as follows in descending order: Powered-on state > Class A faults > Class B faults > Normal state.

The GPS receiver receives the signals from the GPS satellite system, extracts and generates 1PPS signals, and inputs the 1PPS signals as the reference signals to the phase-locked loop (PLL) circuit.

In general, the GPS receiver of the active CC board and that of the standby CC board distribute the signals of a GPS antenna via a power splitter. When the GPS signals are affected by weather conditions or other factors and both the active CC board and the standby CC board involve a class B fault, active/standby switchover does not occur. The system can output stable clock signals within a period of time by relying on the capability of the CC board's crystal oscillator. The services are not affected in this period of time.

3.2.3 RNC GPS Clock

The GPS clock board (ICM_C) of the RNC supports GPS clock synchronization. To provide this function, the ICM_C board needs to be equipped with a Trimble GPS receiver. GPS signals are input from the SMA connector on the front panel of the ICM_C board.

After the ICM_C board is powered on, the CPU initializes the GPS receiver. Initially the GPS receiver can interpret its own geographical location and time information only when it can find four or more satellites. Since the location of the GPS receiver is fixed, the system can stably output time information as long as the GPS receiver can find at least one satellite later. The GPS satellite search results are greatly affected by weather and the environment. The GPS antenna should be installed at a barrier-free position highly above the ground, such as the building rooftop. The space above the GPS antenna should be open. In addition, to achieve a good effect, ensure that no obstacles exist in the range of the elevation angle above 10 degrees.

The faults of the ICM_C board are classified by GPS module faults into class A faults and class B faults.

Class A faults of the GPS module: the 16chip is out of lock or lost, the 12.8M is out of lock or lost, the PP2S output is lost, the 8K output is lost, or the 10M output is lost.

Class B faults of the GPS module: The antenna feeder is shorted or disconnected, the satellite searching performance is poor or no satellite signal can be detected, or the 10M OCXO auxiliary phase is in control (the phase difference is great).

The ICM_C board provides the automatic failover function. When the active ICM_C board detects that the fault level of the standby ICM_C board is lower than its own fault level, it automatically initiates active/standby switchover. The fault levels are sorted as follows in descending order: Powered-on state > Class A faults > Class B faults > Normal state.

The GPS receiver receives the signals from the GPS satellite system, and extracts and generates 1PPS signals and the navigation message (TOD message). The 1PPS signals are input as reference signals to the phase-locked loop (PLL) circuit to generate the phase-locking reference source (8K clock) of the ICM_C board and the PP2S clock signals that are distributed to various service boards. The TOD message is distributed via UART to the CPU and then distributed through 100M Ethernet control flows to the RNC.

In general, the GPS receiver of the active ICM_C board and that of the standby ICM_C board distribute the signals of one GPS antenna via a power splitter. When the GPS signals are affected by weather conditions or other factors and both the active ICM_C board and the standby ICM_C board involve a class B fault, active/standby switchover does not occur. The system can output stable clock signals within a period of time by relying on the capability of the ICM_C board's crystal oscillator. The services are not affected in this period of time.

3.3 IEEE 1588 Clock Synchronization

3.3.1 Overview

Since the Ethernet does not pose network synchronization requirements, it does not involve the transmission of synchronization information. The other networks in the link layer, such as E1 and SDH networks, however, pose network synchronization requirements. Therefore, synchronization information is encapsulated in frames to be transmitted in the corresponding link layer.

In the UTRAN, clock synchronization is required between NEs. For networks that do not pose synchronization requirements but are based on data packet transmission, the IEEE has defined a network time synchronization protocol IEEE 1588, also called the Precision Time Protocol (PTP). This protocol adopts the master-slave synchronization mode. The slave port can obtain synchronization information from the master port to implement high-precision time synchronization.

IEEE 1588 protocol messages are borne over UDP and classified into two types: EVENT message and GENERAL message. The UDP destination port number is defined as follows:

1 In an EVENT message, the UDP destination port number must be 319.

2 In a GENERAL multicast message, the UDP destination port number must be 320.

3 In a GENERAL unicast message sent to the CLOCK, the UDP destination port number must be 320.

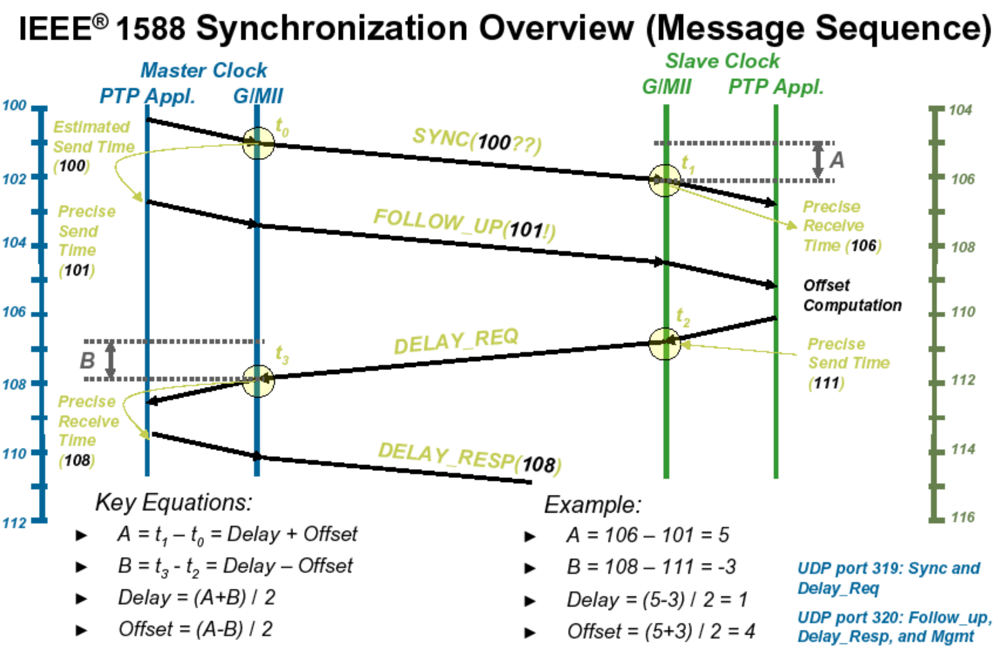
4 In a GENERAL unicast message sent to the MANAGER, the UDP destination port number must be the UDP source port number in the PTP message to which this unicast message responds.

In practical implementation, the EVENT messages include the SYNC message and the DELAY_REQ message, whereas the GENERAL messages include the FOLLOW UP message, the SIGNALING message, the ANNOUNCE message and the DELAY_RESPONSE message.

3.3.2 Principles of IEEE 1588

Figure 3-2shows the working principles of IEEE 1588.

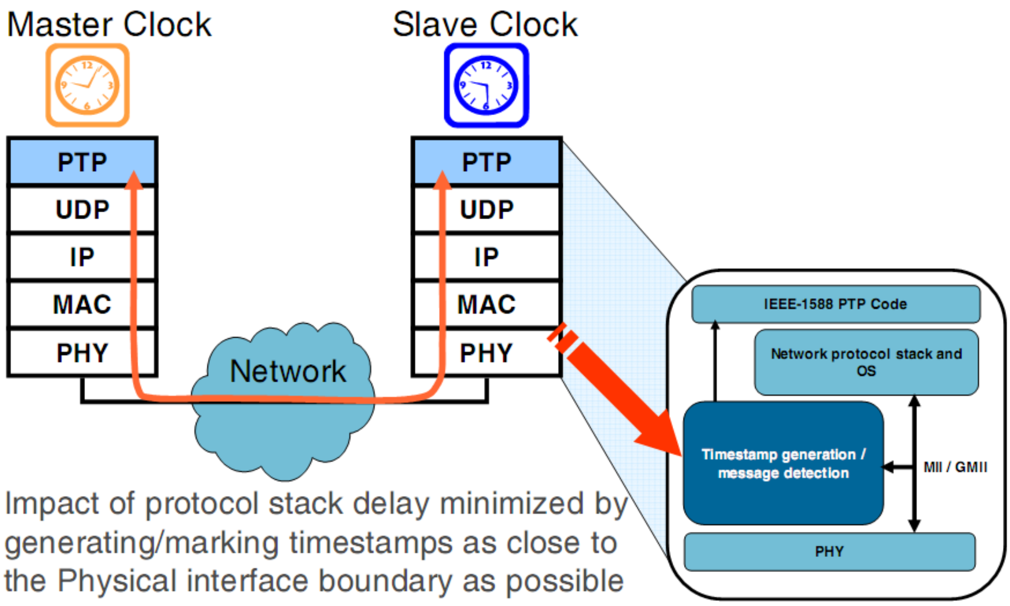
Figure 3-2 Working Principles of IEEE 1588



As shown in 错误！未找到引用源。, the Slave Clock obtains the delay between itself and the Master Clock as well as the clock reference offset between itself and the Master Clock, and then sets the local Slave Clock, so as to ensure that the Slave Clock is synchronized to the Master Clock. Suppose the Master Clock is Clock_m, then the Slave Clock is calculated by this formula: Clock_s = Clock_m + Offset + Delay.

Figure 3-3 shows the protocol stack of IEEE 1588 messages (PTP messages):

Figure 3-3 Protocol Stack of PTP Messages

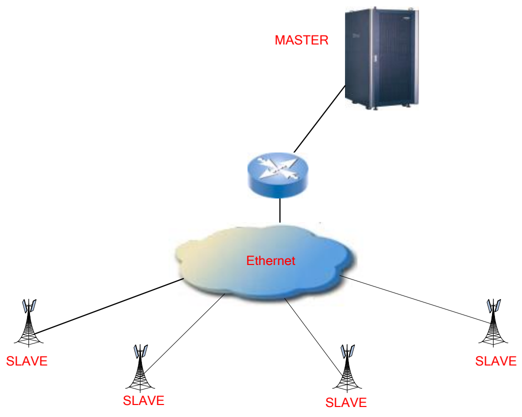


For details on the format of a PTP message, refer to the IEEE 1588 protocol.

3.3.3 Networking in the UTRAN

The Node B serves as the Slave Clock. The RNC implements the Master Clock.

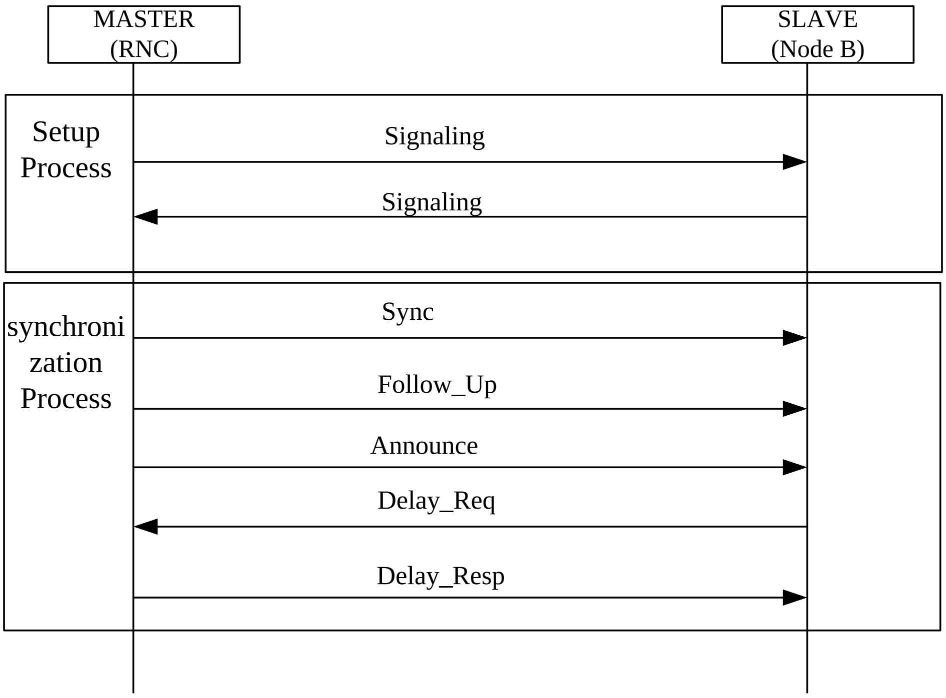
Figure 3-4 Networking



3.3.4 Implementation of Clock Synchronization in the UTRAN

Figure 3-5 shows the message flow between the Master Clock and the Slave Clock.

Figure 3-5 Message Flow



In the setup procedure, RNC set the PTP role according to *Ptp Role*, then the Master and the Slave exchange Signaling messages to negotiate clock synchronization parameters, such as the sending interval of the Sync message. After a link is successfully set up between the Master and the Slave, the synchronization procedure follows. The Master periodically sends the Sync message according to the sending interval negotiated in the setup procedure, and also sends the Follow_Up message, and periodically sends the Announce message. The Slave irregularly sends the Delay_req message. Upon receipt of the Delay_req message, the Master immediately returns the Delay_resp message.

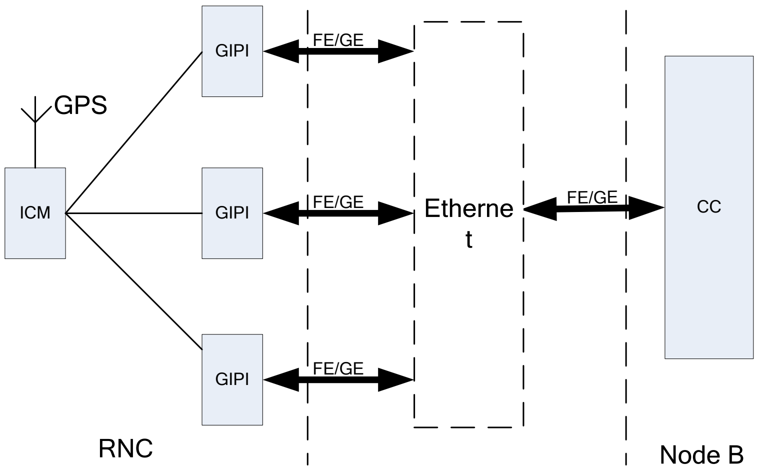
The following table describes the functions of the messages involved in Figure 3-5.

Message	Function	Sending Direction	Sending Frequency
Signaling	Used to negotiate clock synchronization parameters, such as the sending interval of the Sync message	SLAVE->MASTER MASTER->SLAVE	Sent when the Slave requests the Master to provide services.
Sync	Used by the Master to periodically send time synchronization information to the Slave	MASTER->SLAVE	Sent at most once every 2^{-6} s to the Slave. The sending frequency expected by the Slave is determined by the Grant TLV in the Signaling message sent by the Slave.
Follow_Up	Used in pair with the Sync message to carry the time information sent by the Sync message	MASTER->SLAVE	Sent along with the Sync message.
Announce	Used to report the status of Master	MASTER->SLAVE	Sent at most once every 2^{-6} s to the Slave. The sending frequency expected by the Slave is determined by the Grant TLV in the Signaling message sent by the Slave.
Delay_Req	Sent as a delay request	SLAVE->MASTER	Irregularly sent by the Slave. The minimum sending interval of this message is determined by the logMinDelayReqInterval IE.
Delay_Resp	Sent in pair with the Delay_Req message to carry the time information after the Delay_Req message is received	MASTER->SLAVE	Sent as a response to the Delay_Req message.

The *ClockID* of the IEEE1588 clock reference source is 8.

Figure 3-6 shows the hardware function blocks of IEEE 1588 clock synchronization between the RNC and the Node B.

Figure 3-6 Hardware Function Blocks



The clock board (ICM) of the RNC obtains clock signals from the GPS and periodically (at an interval of 16 seconds) synchronizes itself to the Ethernet interface board.

The Node B obtains the clock reference from the RNC according to the procedure defined in the IEEE 1588 protocol and adjusts the local clock accordingly to implement clock synchronization.

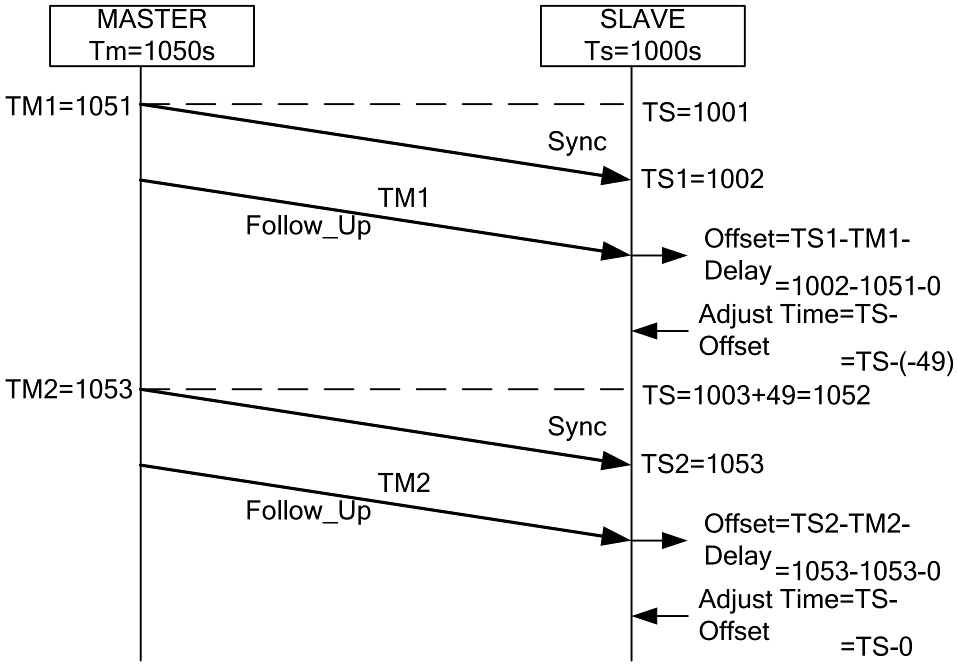
The clock synchronization procedure is described as follows. The Master refers to the RNC, whereas the Slave refers to the Node B.

First, the Master sends signaling messages to request the Master to provide the clock reference and to negotiate clock synchronization parameters with the Master.

The synchronization procedure is divided into two phases: offset measurement phase and delay measurement phase.

In the offset measurement phase, the time offset between the Master and the Slave is adjusted. The Master periodically sends a Sync message, which contains a time stamp that exactly describes the expected time to send the message. As shown in 错误！未找到引用源。, suppose the time of the Master is 1050s (Tm = 1050s) and that of the Slave is 1000s (Ts = 1000s) before the synchronization. The Master measures the accurate message sending time Tm1, whereas the Slave measures the accurate message receiving time Ts1. Since the time stamp in the message indicates the expected message sending time but not the actual message sending time, the Master sends a Follow_Up message after sending the Sync message. The Follow_Up message contains a time stamp that accurately records the actual sending time Tm1 of the Sync message. Therefore, the Slave can use the actual sending time Tm1 of the Sync message carried in the Follow_Up message and the actual receiving time Ts1 of the Sync message to calculate the time offset between the Master and the Slave itself.

Figure 3-7 Message Flow in the Offset Measurement Phase



Note: The delay is calculate in the next process, and set to zero in this process.

Offset = Ts1 - Tm1 - Delay

Note:

1 Difference between Delay and Offset

The Offset refers to the time offset between the Master and the Slave.

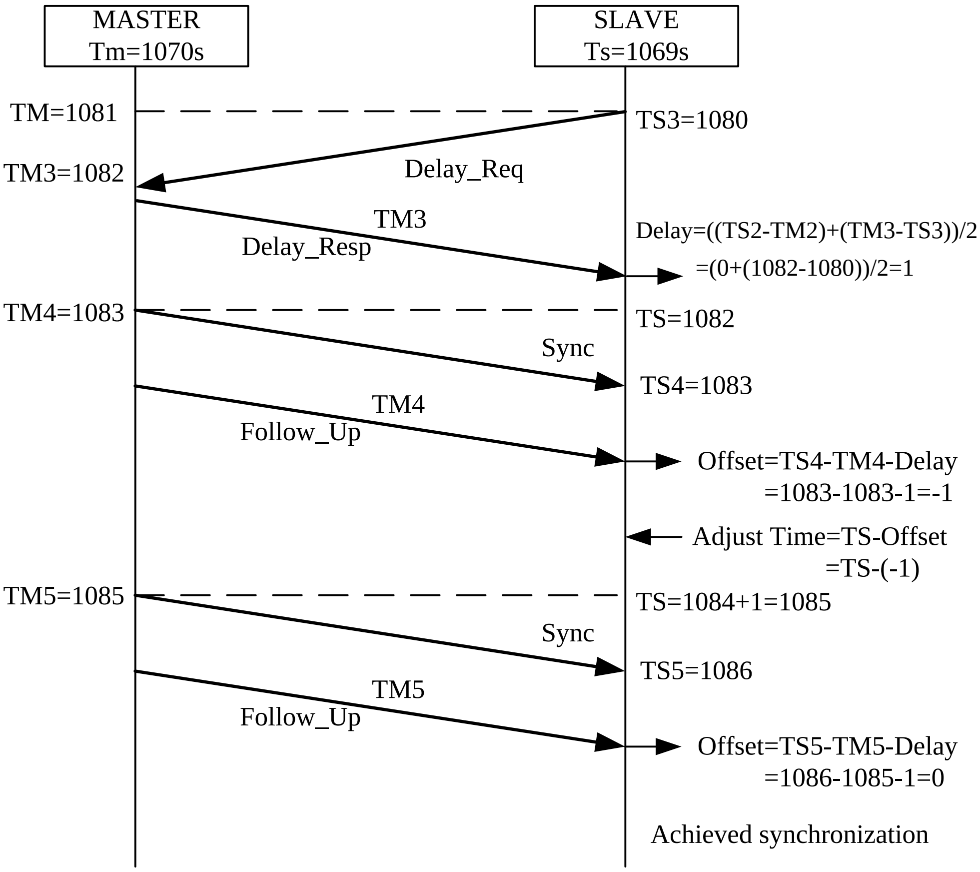
The Delay refers to the transmission delay between the Master and the Slave.

2 In this example, many preconditions are supposed to be met, for instance, the Master and the Slave is syntonized and the transmission is symmetrical.

3 In the above calculation formula, the Delay refers to the transmission delay between the Master and the Slave. This delay is measured in the subsequent delay measurement phase. Therefore, the delay is still unknown here. In the offset measurement phase, Adjust Time (Adjust Time = Ts - Offset) is provided to adjust the Slave.

In the delay measurement phase, the network transmission delay is measured. To measure the network transmission delay, the IEEE 1588 protocol defines a delay request packet, called the Delay_Req.

Figure 3-8 Message Flow in the Delay Measurement Phase



As shown in Figure 3-8, the Slave sends a Delay_Req message at Ts3 after receiving the Sync message. Upon receipt of the Delay_Req message, the Master adds the accurate receiving time Tm3 as the time stamp in a Delay_Resp message and sends the Delay_Resp message to the Slave. Therefore, the Slave can accurately calculate the network transmission delay:

Tm2 -> Ts2: Delay1 = Ts2 – (Tm2 + Offset)

Ts3 -> Tm3: Delay2 = (Tm3 + Offset) - Ts3

Suppose the transmission media are symmetrical. Then the network transmission delay is symmetrical and identical. Therefore:

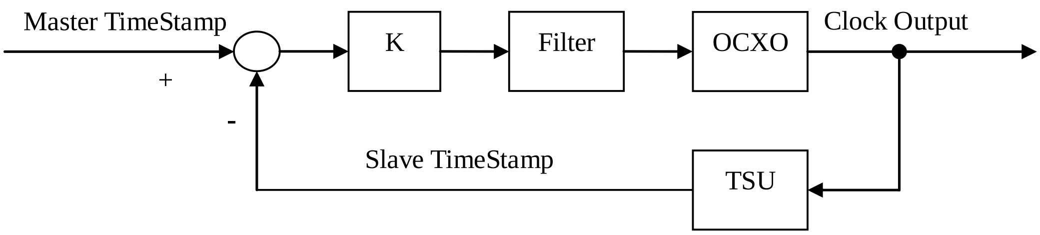
Delay = (Delay 1 + Delay 2) / 2

Unlike the offset measurement phase, the Delay_Req message is randomly sent in the delay measurement phase.

3.3.5 Synchronization Algorithm

Figure 3-9 shows the working principles of the synchronization algorithm:

Figure 3-9 Working Principles of the Synchronization Algorithm



Owning to the characteristics of the transmission network, the difference between the receiving timestamp and the sending timestamp of each Sync message is different. The time difference is the sum of the initial time offset between the Master and the Slave, the time offset caused by the frequency offset between the Master and the Slave, and the transmission delay. The initial time offset remains unchanged. The transmission delay is random. Only the phase difference caused by the frequency offset will linearly increase with time. Therefore, the frequency offset between the Master and the Slave can be obtained through the wave filter. The Slave adjusts the frequency of OCXO according to this frequency offset so as to implement clock synchronization.

3.3.6 Transmission Network Requirements

The transmission network is complex. Numerous factors, such as the asymmetry between uplink traffic and downlink traffic, network congestion, and packet loss, will result in package delay variation. The IEEE 1588 protocol implements clock synchronization based on the packet transmission technology. The package delay variation in the transmission network poses great challenges to the synchronization performance of IEEE 1588. Therefore, the transmission network must meet some requirements as listed in the following table.

Max Delay	Max Delay Jitter	Max Packets Loss
20 ms	7 ms	0.05%

3.4 SyncE Clock Synchronization

The RNC can transmit clock through SyncE. When FE or GE transmission is used on the Iub interface, RNC can transmit the system clock to Node B by set the Iub interface ports as SyncE support (*Host Mode Clock*) and send SSM message to Node B (*SSM code*).

To provide this function, the RNC need to configure GIPI4 board with SyncE support.

The Node B can extract clocks from SyncE. When FE or GE transmission is used on the Iub interface, clocks extracted from the SyncE can be used as the clock reference.

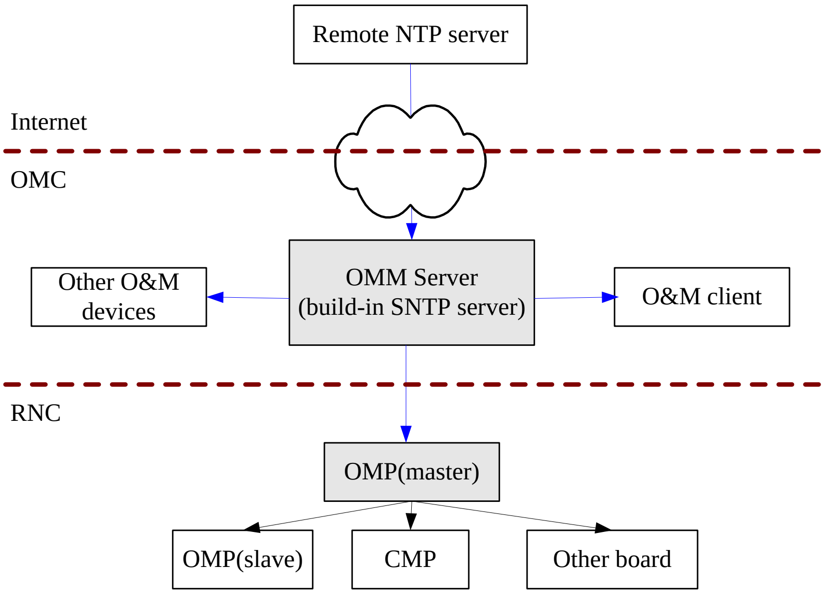
The *ClockID* of the SyncE clock reference source is 9.

To provide this function, the Node B need to configure UES board with SyncE support.

3.5 Time synchronization via SNTP for RNC

3.5.1 The topology of SNTP network for RNC

Figure 3-10 The topology of SNTP network for RNC

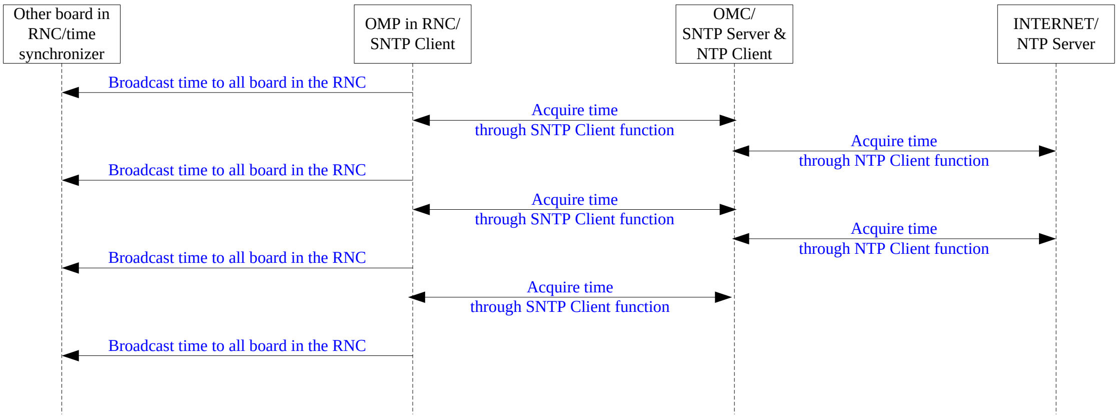


OMM Server, which act as a NTP client, acquires time from the upper NTP server via INTERNET, and serves RNC as the SNTP server via the build-in SNTP function. The time synchronization process can be initiated automatically, and it can be initiated manually also.

The build-in SNTP server in OMM Server can be replaced by a remote SNTP server which connect with RNC via IP interface provided by the board in RNC. In this case, OMP can acquire time from the remote SNTP server, then OMCR acquire time from OMP and synchronizes it to other O&M devices. The method in which SNTP server will be disposed can be configured with parameter *SNTP form mode*. At present, only SNTP server build in OMM server can be supported.

3.5.2 Process of SNTP time synchronization

Figure 3-11 Process of SNTP time synchronization



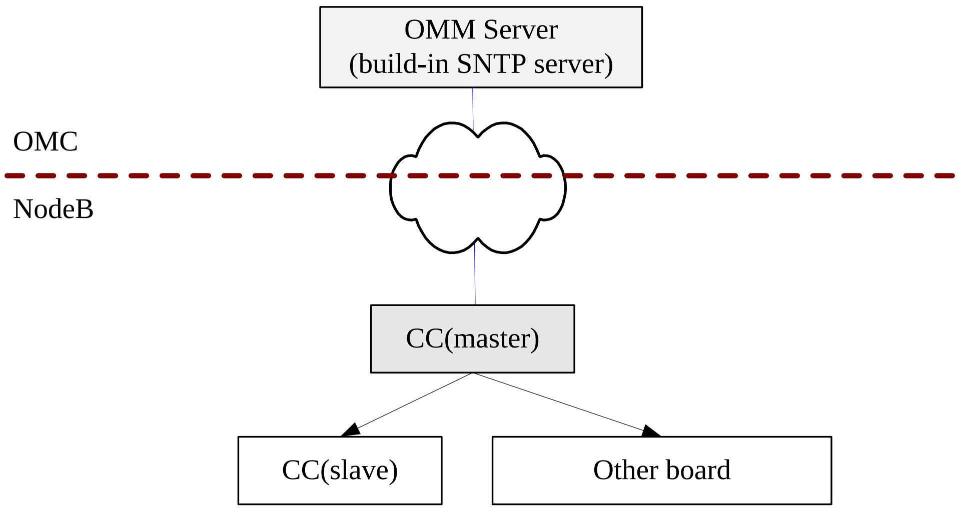
Automatic synchronization: OMM Server acquire time from NTP server periodically, then update the local time and the time value stored in build-in SNTP server. OMP acquires time via SNTP client function from SNTP server build in OMM Server periodically(period can be configured with parameter *SNTP synchronization period(ms)*), then distributes the time value to other processors in RNC.OMP calculate absolute value difference of time value received from OMM server and OMP local time. If the value difference exceed a pre-configured limit (configured with *SNTP error threshold*), then OMP stops automatic synchronization process and alarm to OMCR. It is up to the OMCR operator to decide whether initiate a manual synchronization process or eliminate error occurred in SNTP Server.

manual synchronization: OMCR operator can send a time synchronization command to OMP to force OMP initiate a time synchronization process. OMP in the RNC then acquire time from SNTP server build in OMCR via SNTP client function immediately, and then distribute the time value to other processors inner RNC.

3.6 Time synchronization via SNTP for NodeB

3.6.1 The topology of SNTP network for NodeB

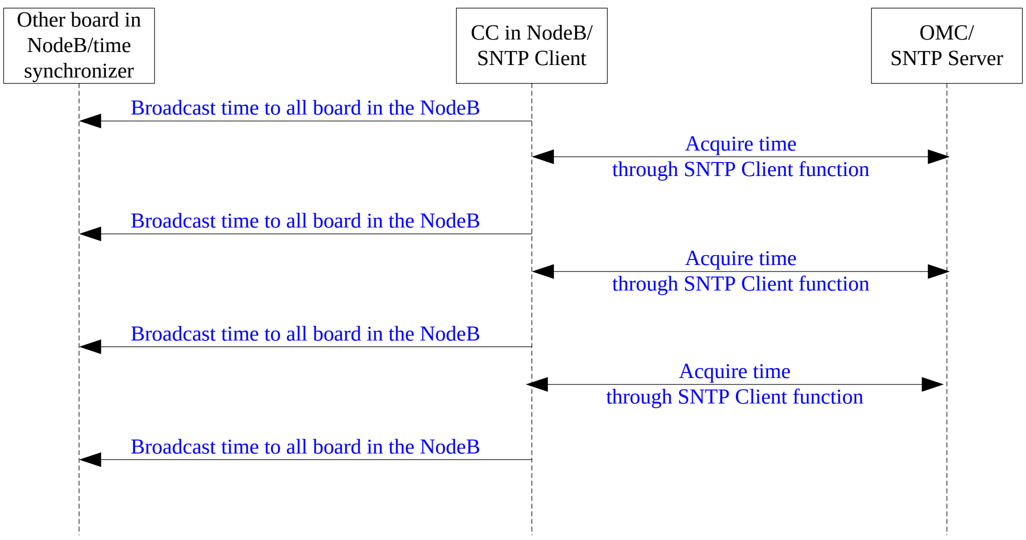
Figure 3-12 The topology of SNTP network for NodeB



OMM Server serves NodeB as the SNTP server via the build-in SNTP function. The time synchronization process can be initiated automatically, and it can be initiated manually also.

3.6.2 Process of SNTP time synchronization

Figure 3-13 process of SNTP time synchronization



Automatic synchronization: CC acquires time via SNTP client function from SNTP server build in OMM Server periodically(period can be configured with parameter *Clock Sync Period(Hour)*), then distributes the time value to other processors in NodeB. If CC cannot acquire time from SNTP server, then CC alarm to OMCB. It is up to the OMCB operator to decide whether initiate a manual synchronization process or eliminate error occurred in SNTP Server.

manual synchronization: OMCB operator can send a time synchronization command to CC to force CC initiate a time synchronization process. CC in the NodeB then acquire time from SNTP server build in OMCB via SNTP client function immediately, and then distribute the time value to other processors inner NodeB.

4 Parameters and Configuration

4.1 Clock Reference Source

4.1.1 Parameter List

No.	Abbreviated Name	Parameter Name
1	Enable/Disable Clock Reference	Enable/Disable Clock Reference
2	Master Clock Reference	Master Clock Reference
3	Clock reference allowing board switch	Clock reference allowing board switch
4	Clock input impedance	Clock input impedance
5	SSM Configuration	SSM Configuration
6	Class 2 clock base missing behavior	Class 2 clock base missing behavior
7	Host Mode Clock	Host Mode Clock

4.1.2 Parameter Configuration

4.1.2.1 Enable/Disable Clock Reference

- OMC Path

  Path: View -> Configuration Management -> RNC NE -> RNC Ground Resource Management -> Other Configuration -> Alarm Setting -> Clock(ICM) Board Alarm Parameters0 -> Enable/Disable Clock Reference

- Parameter Configuration

  This parameter indicates whether to allow clock-related setting.

4.1.2.2 Master Clock Reference

- OMC Path

  Path: View -> Configuration Management -> RNC NE -> RNC Ground Resource Management -> Other Configuration -> Alarm Setting -> Clock(ICM) Board Alarm Parameters0 -> Master Clock Reference

- Parameter Configuration

  This parameter indicates the type of the master clock reference to be set.

4.1.2.3 Clock reference allowing board switch

- OMC Path

  Path: View -> Configuration Management -> RNC NE -> RNC Ground Resource Management -> Other Configuration -> Alarm Setting -> Clock(ICM) Board Alarm Parameters0 -> Clock reference allowing board switch

- Parameter Configuration

  This parameter indicates all the clock references that can be put into use.

  This field uses different bits to represent different clock references. When a bit is set to 1, the corresponding clock reference is used. When a bit is set to 0, the clock reference is not used.

4.1.2.4 Clock input impedance

- OMC Path

  Path: View -> Configuration Management -> RNC NE -> RNC Ground Resource Management -> Other Configuration -> Alarm Setting -> Clock(ICM) Board Alarm Parameters0 -> Clock input impedance

- Parameter Configuration

  This parameter indicates the clock input impedance.

  This field uses different bits to represent different impedance values. Only one of the bits can be set to 1.

4.1.2.5 SSM Configuration

- OMC Path

  Path: View -> Configuration Management -> RNC NE -> RNC Ground Resource Management -> Other Configuration -> Alarm Setting -> Clock(ICM) Board Alarm Parameters0 -> SSM configuration

- Parameter Configuration

  This parameter indicates the clock quality level of reference clocks on the clock board (ICM). When RNC enable the Synchronous Ethernet transmit clock function, the current reference clock's *SSM Configuration* will be sent to Node B.

  The *SSM Configuration* can be set to "Extract SSM from Clock Source" or set a special value. The available value is:

  Unknown: Traceability Unknown

  Prc: Primary Reference Clock that is defined in Recommendation G.811

  Tnc: Transit Node Clock (Recommendation G.812)

  lnc: Local Node Clock (Recommendation G.812)

  Sets: SDH or EEC1 Clock

  Dnu: Do not be used for synchronization

4.1.2.6 Host Mode Clock

- OMC Path

  Path: View->Configuration Management->RNC NE->RNC Ground Resource Management-> Rack -> GIPI3 -> Show Board Properties Page -> Subunit configuration -> Subunit detail -> Host Mode Clock

- Parameter Configuration

  This parameter indicates the interface board enable SyncE function or not.

  When the parameter is set to "Synchronous operation mode is supported", the RNC can transmit system clock through the interface board, and send SSM message to Node B. When the parameter is set to "Synchronous operation mode is not supported", the RNC do not transmit system clock through the interface board.

4.1.2.7 Class 2 clock base missing behavior

- OMC Path

  Path: View -> Configuration Management -> RNC NE -> RNC Ground Resource Management -> Other Configuration -> Alarm Setting -> Clock(ICM) Board Alarm Parameters0 -> Class 2 clock base missing behavior

- Parameter Configuration

  This parameter indicates the behavior of clock board after class 2 clock base missing.

  When the reference clock is lost, the RNC can work in two behavior depending on the configuration of Class 2 clock base missing behavior. If the parameter is set to “In Keep State”, the clock board would keep current clock and if the parameter is set to “Research other base source”, the clock board would switch the clock source to other available reference clock.

4.2 Clock Source Priority

4.2.1 Parameter List

No.	Abbreviated Name	Parameter Name
1	Clock reference source type	Clock reference source type
2	Priority	Priority

4.2.2 Parameter Configuration

4.2.2.1 Clock reference source type

- OMC Path

  Path: View -> Configuration Management -> NodeB NE -> Base Station Config Set -> Equipment object -> Clock device object -> Clock reference source type

- Parameter Configuration

  This parameter indicates the clock reference source type.

4.2.2.2 Priority

- OMC Path

Path: View -> Configuration Management -> NodeB NE -> Base Station Config Set -> Equipment object -> Clock device object --> Priority

- Parameter Configuration

This parameter indicates the priority.

4.3 Static Route

4.3.1 Parameter List

No.	Abbreviated Name	Parameter Name
1	Sync server IP Address	Sync server IP Address
2	IPID used by SDR clock	IPID used by SDR clock
3	IP Qos	IP Qos

4.3.2 Parameter Configuration

4.3.2.1 Sync server IP Address

- OMC Path

Path: View -> Configuration Management -> NodeB NE -> Base Station Config Set -> Equipment object ->IP clock parameter object -> Sync Server IP Address

- Parameter Configuration

This parameter indicates the IP address of the Sync server.

4.3.2.2 IPID used by SDR clock

- OMC Path

Path: View -> Configuration Management -> NodeB NE -> Base Station Config Set -> Equipment object -> IP clock parameter object -> IPID used by SDR clock

- Parameter Configuration

This parameter indicates the IP address of the base station clock.

4.3.2.3 IP Qos

- OMC Path

Path: View -> Configuration Management -> NodeB NE -> Base Station Config Set -> Equipment object -> IP clock parameter object -> IP Tos

- Parameter Configuration

This parameter indicates the IP Qos.

4.4 IEEE 1588 Clock Synchronization

4.4.1 Parameter List

No.	Abbreviated Name	Parameter Name
1	Ptp Role	Ptp Role

4.4.2 Parameter Configuration

4.4.2.1 Ptp Role

- OMC Path

Path: View->Configuration Management->RNC NE->RNC Ground Resource Management->Transmission Configuration->Ip Protocol Stack Configuration->Ptp Role

- Parameter Configuration

This parameter is used to configure the role of the port, such as onestep, twostep, disable.

4.5 Time synchronization via SNTP for RNC

4.5.1 Parameter List

No.	Abbreviated Name	Parameter Name
1	INFO9	SNTP server IP address
2	INFO10	SNTP synchronization period(ms)
3	INFO22	SNTP error threshold
4	INFO22	SNTP form mode
5	INFO24	The NE clock synchronization source

4.5.2 Parameter Configuration

4.5.2.1 SNTP Server IP Address

- OMC Path

  Path: View -> Configuration Management -> RNC NE ->RNC Ground Resource Management->SNTP server IP address

- Parameter Configuration

  This parameter indicates the IP address of the SNTP server build-in OMCR.

4.5.2.2 SNTP synchronization period(ms)

- OMC Path

  Path: View -> Configuration Management -> RNC NE ->RNC Ground Resource Management->SNTP synchronization period(ms)

- Parameter Configuration

  This parameter indicates the frequency of the time synchronization.

4.5.2.3 SNTP error threshold

- OMC Path

  Path: View -> Configuration Management -> RNC NE ->RNC Ground Resource Management->SNTP error threshold

- Parameter Configuration

  This parameter indicates the allowed max difference between OMP local time value and time value acquired form SNTP server.

4.5.2.4 SNTP form mode

- OMC Path

  Path: View -> Configuration Management -> RNC NE ->RNC Ground Resource Management-> SNTP form mode

- Parameter Configuration

This parameter indicates whether the SNTP server is build in OMCR or a remote server.

4.5.2.5 The NE clock synchronization source

- OMC Path

  Path: View -> Configuration Management -> RNC NE ->RNC Ground Resource Management-> The NE clock synchronization source

- Parameter Configuration

  This parameter indicates whether the NE clock synchronization source is NTP server or not.

4.6 Time synchronization via SNTP for NodeB

4.6.1 Parameter List

No.	Abbreviated Name	Parameter Name
1	NTP server IP address	NTP server IP address
2	Clock synchronization period	Clock synchronization period

4.6.2 Parameter Configuration

4.6.2.1 NTP Server IP Address

- OMC Path

  Path: View-> Configuration Mangement -> NodeB NE-> Base Station Config Set -> Equipment object -> Time device object -> NTP Server IP Address

- Parameter Configuration

  This parameter indicates the IP address of the SNTP server build-in OMCB.

4.6.2.2 Clock synchronization period

- OMC Path

  Path: View->Configuration Mangement -> NodeB NE -> Base Station Config Set -> Equipment object -> Time device object -> Clock synchronization period

- Parameter Configuration

This parameter indicates the frequency of the time synchronization.

5 Counter and Alarm

5.1 Counter List

N/A.

5.2 Alarm List

Refer to “ZXWR RNC (V3.09.30) Radio Network Controller Alarm Handling Reference” and “ZXSDR BTS/Node B (V4.09.21) Alarm Handling Reference”.

6 Glossary

B

BITS Building Integrated Timing Supply system

C

CPU Central Processing Unit

G

GPS Global Positioning System

M

MCU Micro Controller Unit

O

OCXO Oven Control Xtal Oscillator

OMC Operation & Maintenance Center

OMP Operation & Maintenance Processor

P

PON PPP Over SDH

PPM	Parts Per Million
PPS	Pulse Per Second
PTP	Precision Time Protocol
R	
RAN	Radio Access Network
S	
SDH	Synchronous Digital Hierarchy
STM	Synchronous Transport Module
T	
TOD	Time Of Day
U	
UART	Universal Asynchronous Receiver/Transmitter
UTC	Coordinated Universal Time

7 Reference

[1] IEEE Std1588™-2008 IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems