

Network synchronization—Stand-alone products that support the design of synchronization networks

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The telecommunications industry acknowledges the importance of good network synchronization, in particular, following the introduction of digital techniques and telecommunications technologies such as WCDMA. What is more, the introduction of Ethernet networks, and the growing number of hybrid (packet- and circuit-switched) network architectures makes clear the requirement to maintain synchronization quality as a means of guaranteeing quality of service (QoS).

To support evolving telecommunications networks, Ericsson provides effective site and network solutions—for example, the Mobile Packet Backbone Network (Mobile-PBN)—as well as specific synchronization solutions. The solutions employ products that are suitable for implementing a reliable, cost-effective and easy-to-operate, dedicated synchronization network. These products—the central building clock (CBC) and GPS system clock (GSC)—are currently available in the common site product portfolio for the core network.

The CBC is fully redundant, stand-alone synchronization equipment (SASE). The GSC is a cost-effective, stand-alone clock controlled by GPS. Each of these products is employed to provide telecommunications equipment with network frequency and time synchronization functions and has been optimized for, but is not limited to, use with Ericsson's main platforms such as AXE and CPP.

The main benefits of synchronization networks based on these products are a flatter synchronization-distribution hierarchy, improved reliability, and greatly reduced overall costs of operation and maintenance (O&M), administration, and provisioning.

The author explains why network synchronization is necessary and what can happen if it is not planned properly. He also introduces the CBC and GSC and describes how Ericsson's solutions meet the requirements of a synchronization network. Although the main focus of this article is on frequency synchronization, Ericsson's solutions also provide an accurate time synchronization reference.

Introduction

Network synchronization is a generic concept that depicts a way of distributing common time and frequency references to all the nodes of a network, to align their respective time and frequency scales (Box B). The role of network synchronization, especially in the context of frequency accuracy, has grown in importance since the late 1970s, when digital transmission and switching were introduced. Today it strongly influences the quality of most operator services.

The effect of poor synchronization in a telecommunications network is strictly related to the services carried. Digital switching equipment, for example, must be synchronized to avoid slips (Figure 1)—although slips have little effect on plain voice service, they have major impact on circuit-data services (Box C).

The deployment of synchronous optical network (SONET) and synchronous digital hierarchy (SDH) technologies in the 1990s put new and more stringent requirements on the stability of synchronization systems. This led to a large standardization effort, resulting in several new or updated recommendations.

Network synchronization plays a particularly important role in GSM and WCDMA. Looking ahead, it is also plain to see that it will have a major role in packet-switching environments. Packet switching

BOX A, TERMS AND ABBREVIATIONS

ANSI	American National Standards Institute	IWF	Interworking function	SND	Synchronization network design
BITS	Building integrated timing supply	MGW	Media gateway	SNMP	Simple network management protocol
BSC	Base station controller	M-MGW	Mobile MGW	SNTP	Simple NTP
BTS	Base transceiver station	Mobile-PBN	Mobile Packet Backbone Network	SONET	Synchronous optical network
CBC	Central building clock	MPU	Microprocessor unit	SSM	Synchronization status message
CPP	Connectivity packet platform	MSC	Mobile switching center	SSU	Synchronization supply unit
CPU	Central processing unit	NSR	Network synchronization review	TDEV	Time deviation
DS1	Digital signal, level 1 (1544 kbps framed signal)	MTIE	Maximum TIE	TDM	Time-division multiplexing
E1	2048 kbps framed signal	NTP	Network time protocol	TIE	Time interval error
EMS	Element manager system	O&M	Operation and maintenance	TL1	Transaction language no. 1
ETSI	European Telecommunications Standards Institute	PDH	Plesiochronous digital hierarchy	ToD	Time of day
GGSN	Gateway GSN	PLMN	Public land mobile network	TSC	Transit switching center
GPRS	General packet radio service	POTS	Plain old telephone service	UI	Unit interval
GPS	Global positioning system	PRC	Primary reference clock	UMTS	Universal mobile telecommunications system
GSC	GPS system clock	PRS	Primary reference source	UTC	Coordinated universal time
GSM	Global system for mobile communications	PSTN	Public switched telephone network	UTRAN	UMTS terrestrial radio access network
GSN	GPRS support node	QoS	Quality of service	WCDMA	Wideband code-division multiple access
IP	Internet protocol	SASE	Stand-alone synchronization equipment		
ITU-T	International Telecommunication Union – Telecommunications Standardization Sector	SDH	Synchronous digital hierarchy		
		SGSN	Serving GSN		
		SGSN-G	SGSN for GSM		
		SGSN-W	SGSN for WCDMA		

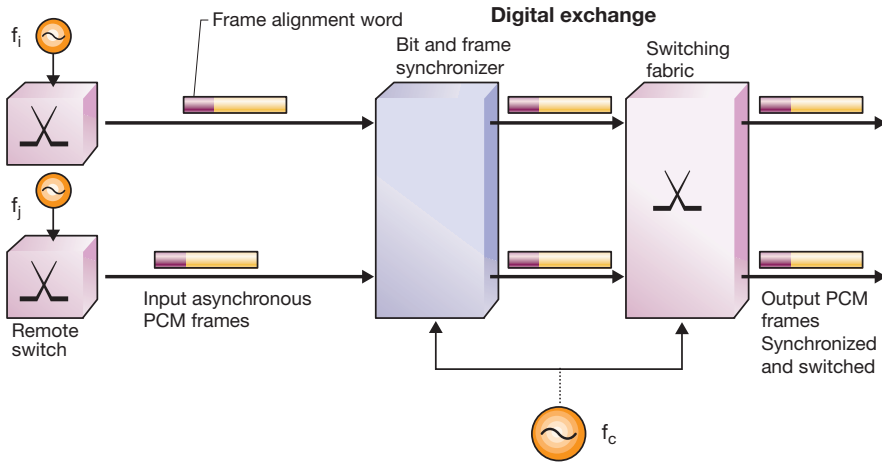


Figure 1
Slips and synchronization requirements of a digital exchange.

Slips are a repetition or deletion of a block of bits in a synchronous or plesiochronous bit stream due to a discrepancy in the read and write rates at a buffer.

was originally introduced to handle typically asynchronous data, but the ongoing evolution of packet networks will call for new and stricter synchronization requirements, including distributing synchronization over asynchronous media, such as Ethernet networks (Figure 2). Extensive work is already underway within relevant standardization bodies to specify requirements and solutions for the correct operation of time-division multiplexing (TDM) transport over packet networks.

Network synchronization strategies and best practices

Network synchronization is achieved by means of a synchronization network that distributes an accurate and reliable reference timing signal to network nodes. At present, two main technologies are used to obtain an accurate reference timing signal: Cesium clocks and clocks based on GPS. Each of these technologies provides an accurate reference timing signal that complies with the basic requirements outlined in ITU-T G.811 and ANSI T1.101.^{1,2} Ordinarily, clocks of this kind are referred to as a primary reference clock (PRC) or primary reference source (PRS).

Different approaches can be used to design a synchronization network. The two most prominent (Figure 3) are

- distributed PRC—a PRC is deployed at every site that needs an accurate synchronization reference; and

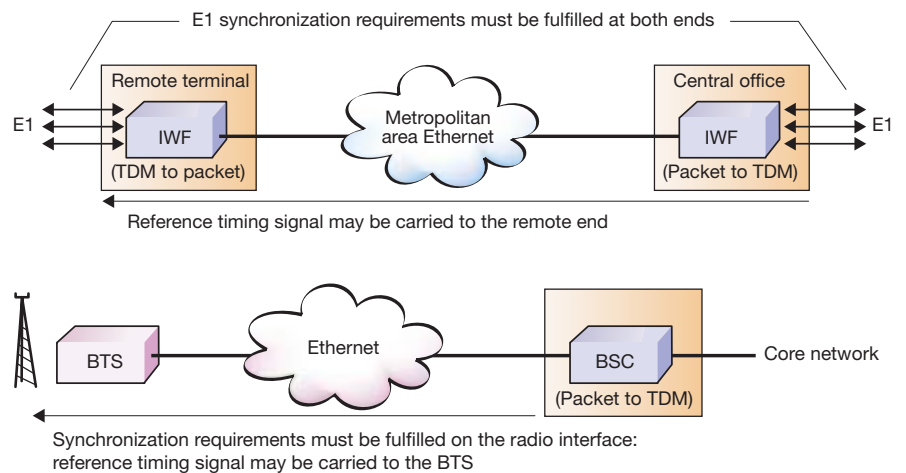


Figure 2
Examples of synchronization aspects in Ethernet networks: circuit emulation services and wireless access networks.

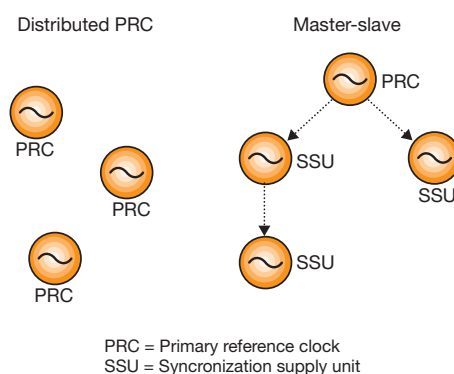


Figure 3
Distributed PRC and master-slave synchronization network.

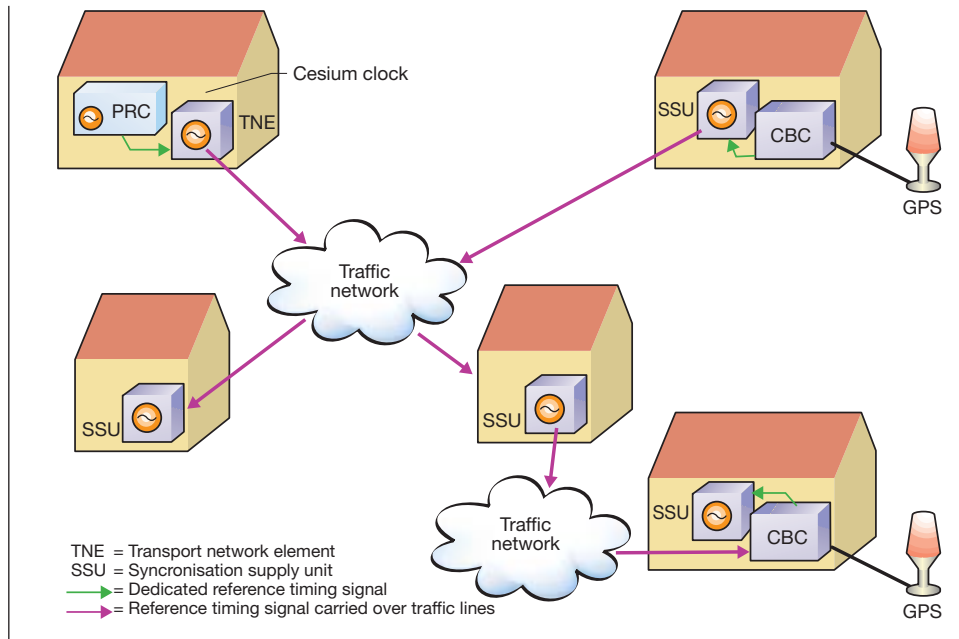


Figure 4
Example of a synchronization network.

BOX B, NETWORK SYNCHRONIZATION: FREQUENCY VS. TIME SYNCHRONIZATION

The term synchronization can mean different things depending on context and who you are talking to. Generally speaking, synchronization is the act of synchronizing the operation of different devices or processes by aligning time scales. The term is also widely used to indicate a common frequency; the more appropriate term, however, is syntonization.

Frequencies can be distributed via dedicated analog signals (typically 2048 KHz) or via digital signals that carry traffic. In the latter case, a typical application is to distribute synchronization via the traffic itself, for instance, on PDH 2048 kbps or 1544 kbps signals. The frequency reference is normally transferred from a stable and accurate clock to a clock of lesser quality via a master-slave scheme (Figure 5).

Time synchronization is the distribution of a

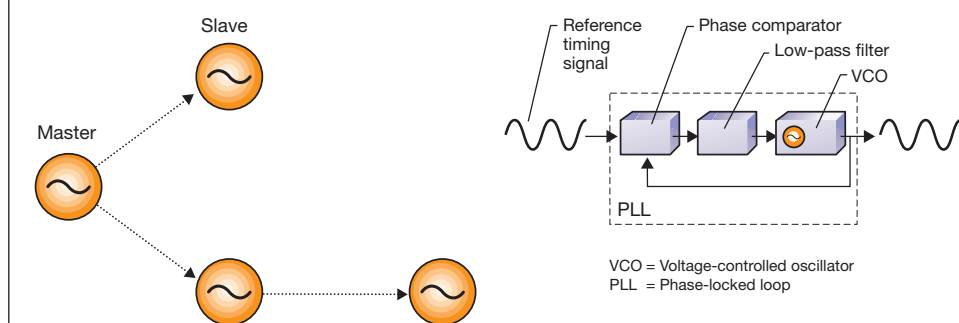
reference absolute time, such as the national standard time, to the real-time clocks of a telecommunications network (synchronization of real-time clocks). Time synchronization is requested whenever network elements need to share a common timescale. Time synchronization has many applications in telecommunications, data communications and power utility networks—for example, precise time stamping for billing, fault isolation, security assurance and transaction processing, and for supporting quality of service (QoS).

The standard timescale of the International Telecommunication Union (ITU) is coordinated universal time (UTC), which is based on the Earth's rotation around the sun and around its axis. UTC is disciplined with respect to international atomic time (TAI) by inserting leap

seconds at intervals of about 18 months. UTC can be distributed using time-of-day (ToD) information through radio and satellite navigation systems (GPS), telephone modems and portable clocks.

An effective and convenient distribution of ToD calls for a hierarchical time synchronization network and a protocol that can read a server clock, transmit the data to one or more clients, and adjust each client clock. In TCP/IP networks, the protocol of choice is the network time protocol (NTP). Developed by David Mills at the University of Delaware, NTP has become an industry standard for synchronizing time in computers and network equipment.⁴ The protocol is based on messages transported over Internet protocol (IP) and user datagram protocol (UDP) packets.

Figure 5
Master-slave method and PLL.



- master-slave—a centrally located PRC distributes the frequency reference via the traffic network or a dedicated network to remote clocks of lesser quality, for instance, synchronization supply units (SSU).

In practice, most telecommunications operators implement a mixed solution; that is, they deploy PRCs at main sites and distribute reference timing signals to remote sites via the traffic network (Figure 4).

The main cause of problems in a synchronization network is usually related to the distribution of reference timing signals via traffic networks. For example, designers need be careful to avoid timing loops in the synchronization network. Timing loops occur when a clock derives the controlling reference timing signal from itself (Figure 6). In this case all associated clocks have a large frequency offset compared to the nominal frequency and are likely to be isolated from the rest of the synchronization network. In other instances, synchronization references are sometimes distributed by leased lines that lack reliable, quality distribution of the reference. Likewise, pointer adjustments in SDH network elements can cause problems in synchronization networks.

Proceeding from analyses of current networks, work on future networks, and relevant guidelines from international standardization bodies (for example, EG 201 793, Ref 3), Ericsson has defined best practices for network synchronization. The main recommendation is to follow a distributed PRC strategy. This approach yields the most reliable and cost-effective solution and is valid in any network scenario. GPS technology facilitates cost-effective deployment of PRCs. Cesium clocks can be considered where it is not feasible to implement a solution based on GPS technology (for instance, for political reasons). Because Cesium clocks are considerably more expensive to use than GPS clocks, they are only deployed at a few main sites or sites where it is not feasible to use GPS primary reference sources. Remote sites, such as base station sites connected via reliable transmission systems, can derive synchronization references from the sites with PRCs.

The recommended site solution (intra-site synchronization) is to implement a stand-alone clock (referred to as SASE or building-integrated timing supply BITS). Ericsson calls these central building clocks (CBC) and has adopted this name for a fam-

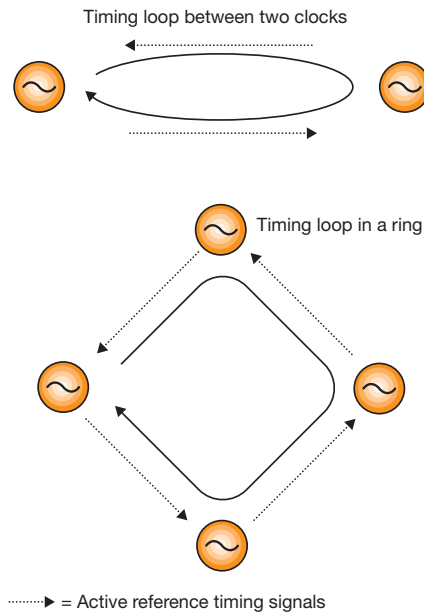


Figure 6
Timing loop.

BOX C, THE EFFECTS OF POOR SYNCHRONIZATION

To prevent loss of information when digital signals are being transported over a link, the receiving end must either operate at the same average frequency as the transmitting end (digital exchanges) or with spare bandwidth capacity (transport network equipment). This applies to every network node involved in transport between the transmitter and receiver.

The task of keeping entities operating at the same average frequency (and within proper quality boundaries) is referred to as network synchronization. If synchronization is poor—that is, if the network nodes do not operate at the same average frequency—impairments, such as slips and bit errors, will occur.

The impact of slips and bit errors in a digital

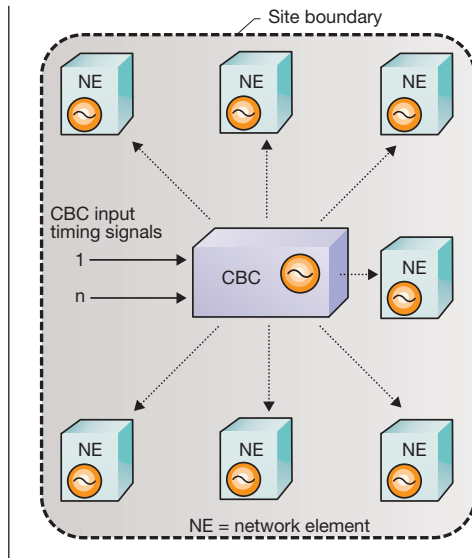
network varies depending on the application and type of service. The impact is greater on services using data with low redundancy, such as narrowband video, than it is on services using data with high redundancy, such as POTS (Table 1).

A common example of impairments in GSM networks is the disconnection of calls during handover. In addition to impairments affecting transmission, consequential errors (such as blocked links) might affect the operation of single-network nodes or even network segments that cause services to be shut off completely. Ultimately, poor synchronization affects quality of service, resulting in a negative effect on operator business.

TABLE 1, POTENTIAL IMPACT OF SLIPS ON SERVICES

Service	Potential impact
Encrypted text	Encryption key must be retransmitted.
Video	Freeze frame for several seconds. Noise burst (“pop”) on audio.
Digital data	Deletion or repetition of data. Possible missframe. Reduction of throughput.
Facsimile	Connection establishment might not succeed. Deletion of 4-8 scan lines or loss of throughput depending on facsimile system.
Voice band data	Transmission errors for 0.01 to 2s. Dropped call (for some modems).
Voice	Possible “click”.

Figure 7
Central building clock (CBC) concept.



ily of equipment. CBC equipment is responsible for distributing reference timing signals to each of the network elements at a site. It monitors and supervises incoming synchronization references and, if the external references are lost, provides a high-quality holdover frequency via an internal oscillator (Figure 7). The CBC concept makes the synchronization network more visible and concentrates synchronization resources into a single device per building.

Figure 8
Photograph of a central building clock (CBC).



Ericsson network solutions

Ericsson currently offers optimized network solutions that fulfill operator requirements for appropriate network synchronization design (frequency and time synchronization). The Mobile-PBN, for example, simplifies the introduction and deployment of packet backbone networks for use in mobile networks. In particular, Mobile-PBN release 3.0 gives operators an optimized and verified solution (including a network synchronization solution) for complete network design. It is part of Ericsson Core Network release 3, which gives efficient rollout of all core network-related services. The Mobile-PBN solution is based on a multiservice backbone for cost-effective interconnection of operator sites, and makes optimized use of backbone bandwidth for voice and data. It includes a complete network-synchronization solution that complies with the recommendations issued by international standardization bodies.

Regardless of network type and technology, however, Ericsson can provide strategic consultation in the area of network synchronization, helping operators to identify and map their needs at every stage of managing the network life-cycle—from designing the synchronization network when planning a new network, to network synchronization audits in order to evaluate the quality and reliability of current network synchronization solutions.

Synchronization products

The CBC and the GSC can each provide stable timing references that are suitable for frequency and time synchronization. They have been customized for optimum integration into Ericsson site solutions—for instance, Mobile-PBN sites. The CBC and GSC are also included in the Core Network Common Site Product portfolio.

Central building clock

The CBC is a fully redundant SASE that provides the network frequency and time synchronization function to any telecommunications equipment (Figure 8). It has been optimized for, but is not limited to, use with Ericsson's main technology platforms—AXE and CPP. The main functions of the CBC are

- to receive, terminate and supervise external network synchronization reference signals;

BOX D, QUALITY PARAMETERS AND CHARACTERIZATION OF TIMING SIGNALS

Several parameters have been defined to specify and measure the quality of the synchronization network and of reference timing signals. The most commonly used parameters are

- frequency accuracy;
- jitter and wander; and
- time error—time interval error (TIE), maximum time interval error (MTIE), and time deviation (TDEV).

Frequency accuracy is defined as the maximum magnitude of the fractional frequency deviation for a specified time period (Figure 9). The fractional frequency deviation $y(t)$ is the difference between the frequency of a signal, $\nu(t)$, and a specified nominal frequency, ν_{nom} , divided by the nominal frequency:

$$y(t) = (\nu(t) - \nu_{nom}) / \nu_{nom}$$

Ordinarily, frequency accuracy is measured in parts per million (PPM). The measure of frequency accuracy is strongly dependent on several external conditions that should always be specified together with the accuracy value. The most vital condition is the time period being considered. Without the time period, the stated accuracy value would have little or no significance. Environmental conditions, such as operating temperature, allowed rate of temperature change, or power supply instabilities, also influence accuracy and should be specified. The frequency accuracy of a system is given by the accuracy of its main clock oscillator.

Jitter is defined as the short-term variation

of the significant instants of a digital signal from its ideal position in time (Figure 10). A common limit for defining the short-term variations is 10 Hz.

Wander is the long-term variation of the significant instants of a digital signal from its ideal position in time (where long-term implies that the variation in frequency is less than 10 Hz). The definition of wander does not usually include long-term variations caused by frequency offset and drift.

Jitter and wander are expressed in units of time, often in terms of unit intervals (UI) or nanoseconds.

Despite the similarity in definitions, jitter and wander often have different sources. One source of wander is a synchronized clock that uses a control mechanism of some kind to maintain a lock on its reference. It is this control mechanism that gives rise to wander, sometimes referred to as clock breathing. Wander can also be caused by environmental factors, such as temperature changes of transmission media. In SDH and SONET transport networks, a major contributor to wander is the pointer adjustment mechanism.

The main sources of jitter are bit-stuffing mechanisms in multiplexers and oscillator-introduced phase noise.

There are several parameters in use for specifying wander in standard specifications, in particular, the two timing parameters—MTIE and TDEV—selected to characterize transients and low frequency noise on a synchronization

interface. These parameters are calculated using measured time error.

The time error of a clock, with respect to a frequency standard, is the difference between the time of the clock and the time of the frequency standard (Figure 11).

Mathematically, the time error function, $x(t)$, between a clock with time $T(t)$ and a reference clock with time $T_{ref}(t)$ is defined as

$$x(t) = T(t) - T_{ref}(t)$$

The MTIE (τ) is the maximum peak-to-peak time error of a given timing signal, with respect to an ideal timing signal, within an observation interval (τ), for all observation times with said length within a specified measurement period.

TDEV is a measure of the expected time error of a signal as a function of integration time. It can also provide information on the spectral content of the phase (or time) noise of a signal.

MTIE is useful for capturing the phase transients in a timing signal, because it describes the maximum phase variation of a timing signal over a period of time. However, because of its sensitivity to phase transients, MTIE does not adequately show the underlying noise on the timing signal.

Random noise is better characterized by TDEV, which is a root-mean-square (RMS) power estimator rather than a peak estimator. TDEV tends to remove transients in a timing signal, and is therefore a better estimator of the underlying noise processes. Detailed definitions of MTIE and TDEV are provided in ITU-T Recommendation G.810.³

Figure 9
Frequency accuracy.

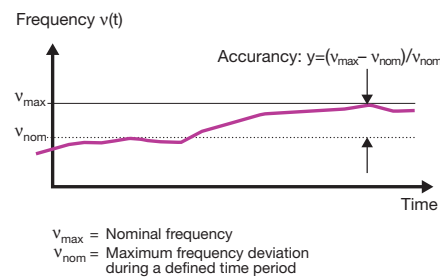


Figure 10
Ideal timing signal (a) and signal affected with Jitter (b).

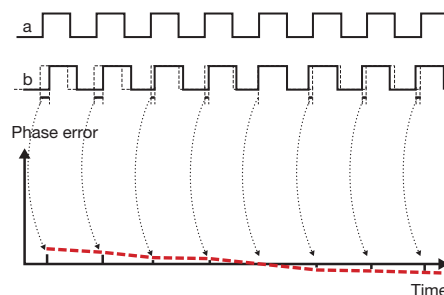


Figure 11
Example of time error.

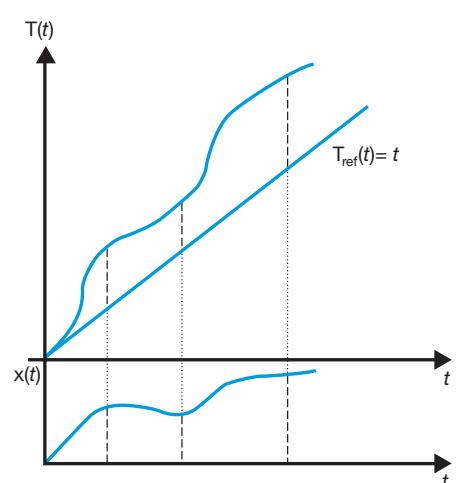




Figure 12
Photograph of a GPS system clock (GSC).

- to distribute frequency reference signals to telecommunications equipment;
- to distribute time-of-day (ToD) to telecommunications equipment;
- to retain highly stable holdover frequencies via a Rubidium oscillator; and
- to protect critical functions, including inputs, oscillators and outputs.

The CBC has an integrated GPS receiver and six inputs that terminate synchronization references carried by traffic links or

dedicated synchronization references. The unit supervises every input, choosing and filtering the preferred references. When a GPS signal is available, the CBC uses it as one of the reference inputs. In this mode, the output quality of the CBC reference clock (PRC) exceeds the requirements specified by ITU-T G.811. The GPS receiver is also used to provide time-of-day to any system that supports the network time protocol (NTP).

Operator benefits of the CBC

Where network synchronization is concerned, the CBC can be used as a cost-effective alternative to a Cesium atomic clock for the implementation of a PRC source. In terms of synchronization distribution, it is highly suited to main or core sites that require reliable, high-quality synchronization. It can synchronize up to 60 different network elements at a site via output signals protected by hardware.

To guarantee proper handling, installation and operation, the CBC has been pre-configured and tested with AXE and CPP. The CBC provides numerous improvements for network elements co-located with it, and in general, improves overall network performance. For example, it

- provides a synchronization solution that caters for evolving networks;
- maintains a stable 14-day holdover frequency according to ITU-T G.811;
- improves the filtering of the incoming synchronization reference signal;
- improves the supervision of incoming reference signals (by means of parameters, such as MTIE and TDEV);
- distributes reliable synchronization reference signals to other equipment located at the site;
- provides full synchronization status message (SSM) support;
- provides full simple network management protocol (SNMP) support; and
- is fully supported by ITU-T-compliant synchronization element manager systems (EMS)—these can be provided with or without a northbound SNMP interface. When locked onto a GPS signal, the CBC also
- supplies synchronization reference signals that are compliant with ITU-T G.811 (long-term accuracy comparable to UTC);
- flattens the synchronization distribution hierarchy;
- improves the reliability of the synchronization network;

TABLE 2. SUMMARY OF THE MAIN CHARACTERISTICS OF AND DIFFERENCES BETWEEN THE FOUR CBC CONFIGURATIONS

CBC Version	Inputs	Oscillators	Outputs
CBC-E: CBC ETSI version	6 x E1 or Analog + GPS	2xRubidium	20 (1+1 protected) E1 + 40 (1+1 protected) 2048 kHz
CBC-A: CBC ANSI version	6 x DS1 or Analog + GPS	2xRubidium	20 (1+1 protected) CC + 40 (1+1 protected) DS1
CBC-SE: CBC for small sites, ETSI version	3 x E1 or Analog + GPS	1 Rubidium + 1 Quartz	20 (1+1 protected) 2048 kHz
CBC-SA: CBC for small sites, ANSI version	3 x DS1 or Analog + GPS	1 Rubidium + 1 Quartz	20 (1+1 protected) DS1

TABLE 3. MAIN BENEFITS TO NETWORK ELEMENTS CO-LOCATED WITH THE GSC

- Supplies synchronization reference signals that are in compliance with ITU-T G.811 (long-term accuracy comparable to UTC).
- Stable, 14-day holdover frequency (ITU-T G.811).
- Distribution of reliable synchronization reference signals to other equipment located at the site.
- Flattens out the synchronization distribution hierarchy.
- Improves the reliability of the synchronization network.
- Provides accurate (Stratum 1) time synchronization via SNTP and Ethernet.
- Facilitates inserting synchronization status messages (SSM) into outgoing framed signals (1544 and 2048 kpbs).
- Is fully supported by ITU-T-compliant synchronization EMS—these may be provided with or without a northbound SNMP interface.

- minimizes the overall costs of O&M, administration, and provisioning associated with the synchronization network; and
- provides accurate (Stratum 1) time synchronization via NTP over Ethernet.

CBC configurations

Ericsson's CBC is available in four configurations (Table 2). Each configuration addresses a specific market and application. Ordinarily, the CBC-E and CBC-A are installed in main sites where a large number of network elements needs to be synchronized to meet tough reliability and supervision requirements. The CBC-SE and CBC-SA are two cost-effective versions that can be installed in main sites where a smaller number of network elements needs to be synchronized to maintain reliability, functionality and supervision.

GPS System Clock

The GSC is a cost-effective, stand-alone clock controlled by GPS. It is used for supplying network-frequency and time synchronization functions to telecommunications equipment (Figure 12).

Like the CBC, the GSC has been optimized for, but is not limited to, use with AXE and CPP. Its main functions are

- to distribute frequency reference signals to telecommunications equipment;
- to distribute time-of-day to telecommunications equipment; and
- to provide a highly stable holdover frequency via a Rubidium oscillator.

The GSC uses a GPS receiver to acquire a reference frequency of the system clock. The internal system clock, in turn, generates a reference signal for all outgoing reference signals.

When a GPS signal is available, the GSC delivers primary reference clock outputs whose long-term stability exceeds the requirements specified by ITU G.811. GPS is also used to provide time-of-day in SNTP format to any system that supports the network time protocol.⁷

Operator benefits of the GSC

The GSC is suitable for use in small sites that require reliable and high-quality synchronization. It can be used to synchronize up to 10 different network elements at a site. Where network synchronization is concerned, it can be used as a cost-effective GPS-based alternative to Cesium atomic clocks for the implementation of a PRC source. It can thus serve as a backup source or as a PRC for smaller sites.

BOX E, CBC TECHNICAL CHARACTERISTICS

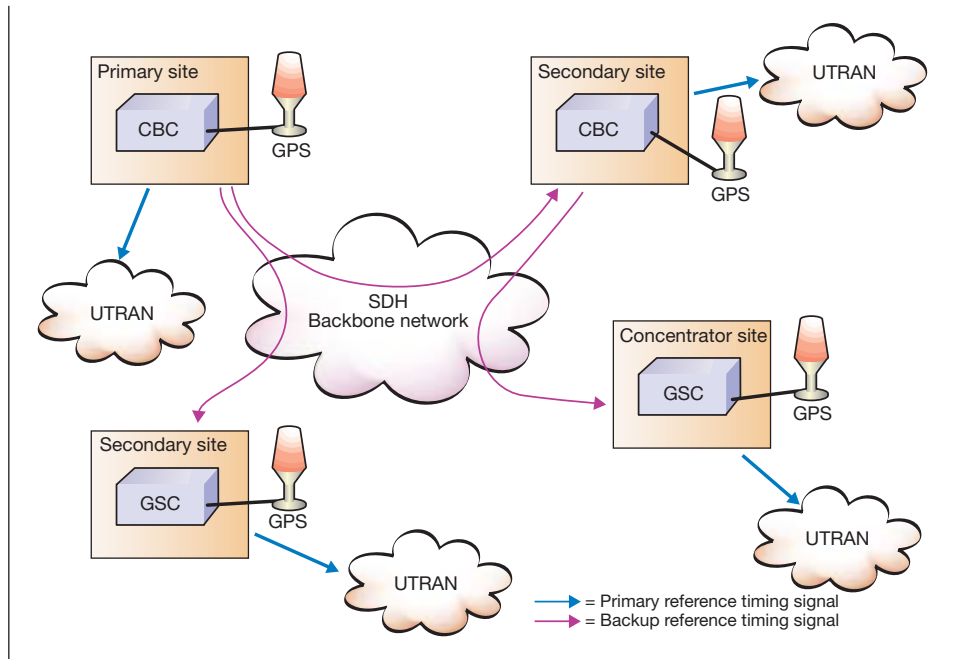
Characteristics System	Specifications
Architecture	2 clock modules 1 communications module 1 or 2 input modules + GPS receiver 2 or 6 output modules
Chassis dimensions (H x W x D)	495 x 432 x 245 mm (fits in BYB 501)
Power connections	2 inputs (-48/60 vDC nominal)
EMC	Fulfills all EMC class-B standards
Input	
Number of inputs	Up to 6 + GPS
Supported interfaces	1 MHz 1.544 MHz 2048 kHz (ITU-T Rec. G.703) 5 MHz 10 MHz E1 (2048 kbps, ITU-T Rec. G.703) DS1 (1544 kbps, ITU-T Rec. G.703)
SSM	Compliant with SSM specifications T1X1.3 TR33, (ANSI) T1.101-1999; Telcordia Technologies GR-253 and 378-CORE; and applicable parts of ITU-T G.781
Clock	
Rubidium oscillator, compliance with international standards	ANSI T1.101 Stratum 2 and ITU-T Rec. G.812 type I/II
Quartz compliance with international standards	ANSI T1.101 Stratum 3E and ITU-T Rec. G.812 type III
Output	
Number of outputs	Up to 60
Supported interfaces	2048 kHz (ITU-T Rec. G.703) E1 (2048 kbps, ITU-T Rec. G.703) DS1 (1544 kbps, ITU-T Rec. G.703) 64+8 kHz composite clock (ANSI T1.101) Exceeds ANSI T1.101 PRS and ITU-T Rec. G.811
Wander output (MTIE and TDEV) CBC locked to GPS	
Wander output (MTIE and TDEV) CBC not locked to GPS	Exceeds ITU-T Rec. G.812 Type I/II or Type III (depending on whether clock is Rubidium or Quartz)
Output jitter	Meets ANSI T1.101 PRS and ITU-T Rec. G.811
Communication	
Physical interfaces	3 RS-232 serial ports 1 Ethernet 10BaseT port (Telnet, NTP, SNMP)
Management protocols	Interactive control set (ICS) Transaction language one (TL1) SNMP version 2 NTP version 3 (RFC 1305)
Time of day	

The GSC has been pre-configured and tested together with AXE and CPP to guarantee proper functionality, handling and installation. Table 3 lists the main benefits of the GSC to network elements co-located with it, and general benefits to overall network performance.

The CBC and GSC in the network

As mentioned above, international standards recommend that stand-alone clocks

Figure 13
CBC and GSC application in the Mobile-PBN



BOX F, GSC TECHNICAL DESCRIPTION

Characteristics	Specifications
System	
Chassis dimensions (H x W x D)	150 x 432 x 213 mm (fits in BYB 501)
Power connections	2 inputs (-48/60 vDC nominal)
EMC	Fulfills all EMC class-B standards
Input	
Number and type	1 x GPS
System clock	
Rubidium compliance with international standards	ANSI T1.101 Stratum 2 and ITU-T Rec. G.812 Type I/II
Outputs	
Number of outputs	10
Supported interfaces	2048 kHz (ITU-T Rec. G.703) E1 (2048 kbps, ITU-T Rec. G.703) DS1 (1544 kbps, ITU-T Rec. G.703) Exceeds ANSI T1.101 PRS and ITU-T Rec. G.811
Wander output (MTIE and TDEV) GSC locked to GPS	Exceeds ITU-T Rec. G.812 Type I/II
Wander output (MTIE and TDEV) GSC not locked to GPS	
Output jitter	Meets ANSI T1.101 PRS and ITU-T Rec. G.811
Communication	
Physical interfaces	2 RS-232 serial ports 1 Ethernet 10BaseT port (Telnet, SNMP)
Management protocols	Interactive control set (ICS) Transaction language one (TL1) SNTP, version 3 (RFC 1769)
Time of day	

should be used to concentrate the synchronization functionality into one piece of equipment. In addition, by means of a GPS reference, the synchronization network can be planned using distributed PRCs to avoid having long synchronization distribution chains. The set of stand-alone synchronization products available in the Ericsson Core Network portfolio is suitable for most typical applications—for instance, main sites and remote sites to which it might be difficult or impractical to distribute a reliable reference timing signal.

Figure 9 shows a typical application of the CBC and GSC in the network—the Mobile-PBN release 3.0, which defines a network model based on different types of network. The illustrated network shows Primary, Secondary and Concentrator sites, which are the most meaningful types of site making up a network. The sites are interconnected via specific transport modules. The Primary sites are the core sites of the network—that is, they are the most important central sites, connected in a full mesh structure. They include transport, distribution, and access functionalities. The Secondary sites, which implement distribution and access functions, are redundantly connected to two Primary sites and possibly to a number of access sites. The Concentrator sites basically

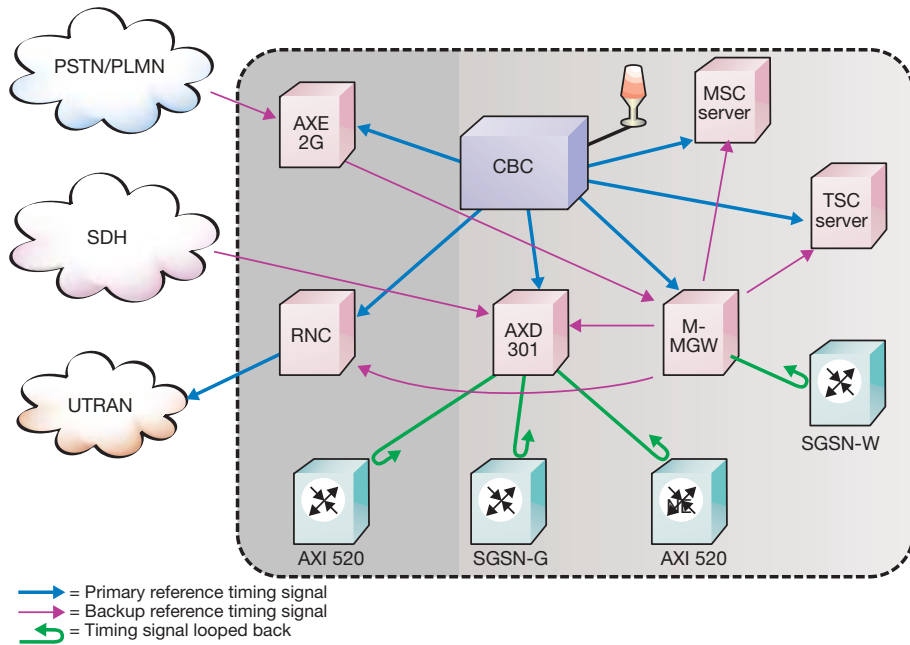


Figure 14
Example of intra-site synchronization in a Mobile-PBN primary site.

implement access functions. They are redundantly connected to one Primary and one Secondary site.

Mobile-PBN release 3.0 employs a distributed PRC architecture that implements the CBC concept at every main site. The importance of the Primary sites necessitates a robust, reliable and redundant source of synchronization. Therefore, in compliance with the distributed PRC approach, it is recommended that a CBC should be used at each Primary site. Figure 14 shows an example of intra-site distribution of synchronization in a primary site.

Secondary sites are smaller than Primary sites. Depending on their role in the network they could be candidates for a simpler clock, such as a GSC.

The CBC configuration is based on site characteristics, such as number of requested reference timing signals and market application (ETSI or ANSI).

Concentrators are the simplest types of site defined in the Mobile-PBN reference network model. They implement core transport capabilities and GSM/GPRS/WCDMA access. The GSC is suitable for this type of site.

Master-slave schemes can be used to provide backup references and to deliver suitable reference timing signals to access networks that are then slaved to the core net-

work. The GSC might also be suitable in some UTRAN sites—for instance, to improve reliability and the quality of the synchronization reference.

Conclusion

A good synchronization network is a fundamental prerequisite for correct operation of any telecommunications network. In particular, this applies to the most recent mobile technologies, such as WCDMA, and hybrid (circuit- and packet-switched) networks, such as those based on Ethernet technology.

By defining reference sites and networks that take into consideration all relevant synchronization requirements, Ericsson has efficiently resolved the difficulties of building complex sites with mixed technologies.

The synchronization products available in Ericsson's core network product portfolio—the CBC and GSC—enable operators to comply with international recommendations in the area of network synchronization, and provide support for frequency and time synchronization. These products give operators reliable and effective solutions for building a wide range of synchronization networks.

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