

Timing over Packet

Nokia Siemens
Networks



Technical Brief

1. Abstract

This paper is designed to help operators understand how to deploy Precision Time Protocol (PTP, or IEEE 1588v2) in mobile networks for the purpose of synchronizing base stations. It introduces the Timing over Packet solution and related design considera-

tions for the transport network between base stations and switching offices. This paper also briefly introduces alternative synchronization technologies and outlines their use in mobile networks.

Table of contents

- 03** Abstract
- 04** Motivation
- 05** Timing over Packet
- 07** Alternatives
- 07** Consultation
- 08** Abbreviations and definitions

2. Motivation

Mobile backhaul networks have traditionally been built using TDM technologies; in particular, PDH and SDH/SONET microwave radios, low capacity SDH/SONET fiber rings, and copper-based E1/T1 leased lines. Given the bandwidth requirements per base station and the nature of the Abis interface in legacy GSM/EDGE and CDMA architectures, TDM is an appropriate bearer – and is also used to distribute the network-wide primary reference clock, from which each base station derives its radio frequency. In order to maintain accuracy to within 50ppb of the nominal radio frequency, the network input must be stable to within 15ppb.

The widespread launch of High Speed Packet Access (HSPA) is driving operators to evolve their backhaul network towards packet transport. While packet-based technologies are actually being deployed for backhauling base stations, the synchronization issue has so far prevented operators from totally substituting their existing TDM network. Ethernet, the commonly envisioned technology for backhaul, is to date inherently asynchronous. Using TDM and packet in parallel is a viable first step; in the long run, however, the majority of operators are looking for ways to migrate completely to packet.

Today's WCDMA base stations still provide E1/T1 interfaces for backhaul. The option to use TDM will practically vanish with 3GPP Long Term Evolution (LTE). The base station's demand for backhaul bandwidth of 100Mbps (and more) calls for broadband transport technologies. A new requirement also reveals itself – time synchronization to microsecond accuracy. To date this can only be achieved by equipping cell sites with GPS receivers.

All of the above has led to Nokia Siemens Networks developing a solution for synchronizing base stations over packet networks in today's WCDMA FDD as well as in future LTE networks. This solution providing simplified, cost-efficient and future proof mobile network synchronization is known as Timing over Packet.

3. Timing over Packet

Timing over Packet is a complete solution for synchronizing WCDMA FDD base stations that are backhauled over packet networks. The solution is based on Precision Time Protocol (PTP, or IEEE 1588v2) and includes:

- An IEEE 1588v2 master, which will typically be located at switching offices. The master is connected to the network-wide reference clock and generates time-stamped packets for a large number of base stations. Timing packets can transparently traverse both Layer 3 and Layer 2 networks. Nokia Siemens Networks has selected Symmetricom, a leading company in synchronization solutions, to become its first supplier for IEEE 1588v2 masters.
- The IEEE 1588v2 slave function, which is fully integrated into Nokia Siemens Networks base stations and which receives the timing packets. The slave function consists of a sophisticated clock recovery algorithm that works in tandem with the base station's high-quality oscillator. Already installed base stations can be easily upgraded. New base stations can be ordered with IEEE 1588v2 support right from the start of the rollout.

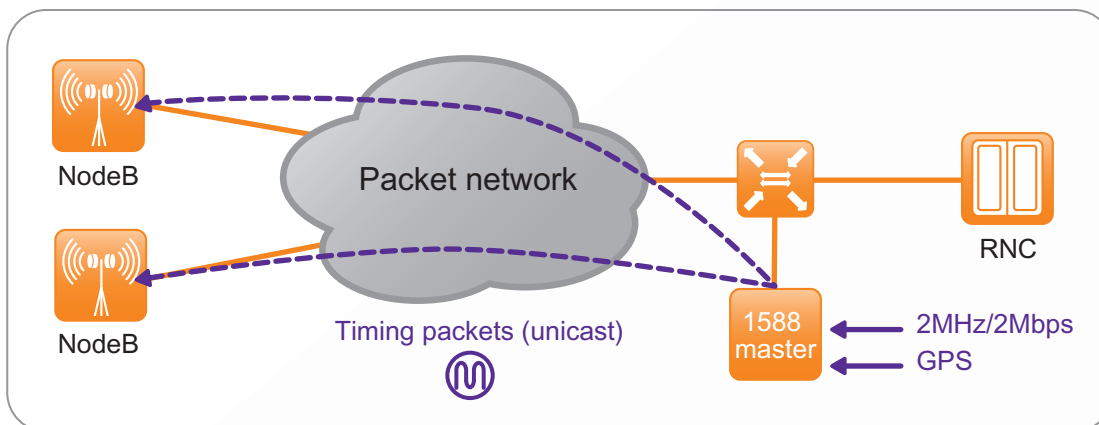


Figure 1: Timing over Packet solution

The third solution component is an educated look at the backhaul network. In principle, PTP works transparently over any packet network. On their way from master to slave, timing packets experience delay, which varies from packet to packet. The base station's IEEE 1588v2 slave function reliably cancels this delay even under adverse network

conditions. Nevertheless, attention has to be paid to certain network design aspects. Quality of Service should be applied at every highly loaded node, to avoid timing packets being queued behind other traffic. Network reconfigurations and automatic rerouting of traffic, causing step changes in packet delay, should be minimized.

Timing over Packet is one of the first significant implementations of PTP. Nokia Siemens Networks is committed to open standards and has been a contributor to IEEE 1588 standardization work. The recently standardized Version 2 incorporates a number of additions that are relevant to wide area network applications – message rates can be higher, unicast is possible, multiple routers can be traversed, and the concept of transparent clocks has been introduced. The Timing over Packet solution is based on the telecom profile proposal of IEEE 1588v2, a subset of features.

Timing over Packet, based on PTP, is a future-proof solution. Today used for frequency synchronization, PTP is the only network timing standard proven to also support time synchronization at sub-microsecond accuracy when implemented across the network. This level of accuracy is required in recently developed and forthcoming mobile technologies such as DVB-H, mobile WiMAX (IEEE 802.16e), and LTE.

4. Alternatives

Synchronous Ethernet (ITU-T G.8261/2/4)

In February 2008, ITU-T consented to the Synchronous Ethernet standard. Unlike PTP, this technology operates on the physical layer, effectively taking many of the SDH synchronization mechanisms over into the packet world. Synchronous Ethernet operates independently of the network load; the downside is that it requires to be supported at every hop along the chain of nodes between the switching office and the cell site. Nokia Siemens Networks is implementing Synchronous Ethernet in various access and aggregation platforms, as well as in WCDMA FDD base stations.

TDM

TDM-based synchronization – the traditional approach – appears to be incompatible with packet networks, but it is not. Upgrading existing SDH networks to Next Generation SDH is a viable alternative for operators to gracefully migrate to packet transport. TDM-based synchronization is also a property of various existing access technologies; the majority of PDH and SDH/SONET microwave radios can be upgraded to convey Ethernet in addition to E1/T1 and STM1/OC3 respectively. SHDSL.bis allows the bonding of multiple copper loops to form a single Ethernet pipe, synchronized by means of NTR. Finally, GPON can natively carry TDM and Ethernet in parallel, while being perfectly synchronous at Layer 1.

5. Consultation

Looking at the variety of options available can be confusing. However, PTP and Synchronous Ethernet should not be regarded as being contradictory – rather, they complement another. In certain environments, the use of a mechanism that is transparent to the backhaul network is inevitable; for example, where mobile operators are leasing Ethernet services from a third party. The Metro Ethernet Forum is in the process of defining mobile backhaul service attributes, although synchronization has been excluded from the first round.

If the backhaul infrastructure is being renewed – for example where SDH/SONET networks are being substituted by Carrier Ethernet technologies – Synchronous Ethernet is also an option. In many cases, a mix of technologies is the best way forward, for example, using NTR for the copper-based first mile and PTP between the DSLAM and the switching office.

Nokia Siemens Networks advises operators in all aspects of network optimization and assurance, and stands for successful base station synchronization, as proven by key performance indicators. With broad experience in fixed and mobile networks, and having all relevant technologies available in house, Nokia Siemens Networks is well positioned to help operators find and deploy the most reliable, cost-efficient, and simple synchronization solution.

6. Abbreviations and definitions

Abis	The logical interface between a base station and its base station controller in GSM/EDGE and CDMA architectures	LTE	3GPP Long Term Evolution
DSL	Digital Subscriber Line	MBMS	Multimedia Broadcast Multicast Service
DSLAM	DSL Access Multiplexer	NTR	Network Time Reference
FDD	Frequency Division Duplex	PTP	Precision Time Protocol
GPON	Gigabit Passive Optical Network	SDH	Synchronous Digital Hierarchy
GPS	Global Positioning System	SHDSL	Symmetric High Bit Rate DSL
		TDD	Time Division Duplex
		TDM	Time Division Multiplex

Nokia Siemens Networks Corporation

P.O. Box 1

FI-02022 Nokia Siemens Networks

Finland

Visiting address:

Karaportti 3, Espoo, Finland

Switchboard +358-71-400-4000 (Finland)

Switchboard +49-89-515-901 (Germany)

The contents of this document are copyright © 2008 Nokia Siemens Networks. All rights reserved. A license is hereby granted to download and print a copy of this document for personal use only. No other license to any other intellectual property rights is granted herein. Unless expressly permitted herein, reproduction, transfer, distribution, or storage of part, or all, of the contents in any form without the prior written permission of Nokia Siemens Networks is prohibited. The content of this document is provided "AS IS", without warranties of any kind with regards to its accuracy or reliability, and specifically excluding all implied warranties, for example of merchantability, fitness for purpose, title, and non-infringement. In no event shall Nokia Siemens Networks be liable for any special, indirect, or consequential damages, or any damages whatsoever resulting from loss of use, data, or profits, arising out of, or in connection with, the use of the document. Nokia Siemens Networks reserves the right to revise the document or withdraw it at any time without prior notice. Nokia Siemens Networks and the Wave logo are registered trademarks of Nokia Siemens Networks. Nokia Siemens Networks product names are either trademarks or registered trademarks of Nokia Siemens Networks. Other product and company names mentioned herein may be trademarks or trade names of their respective owners.

Order No. C401-00106-B-200803-2-EN