

# Synchronization and Timing in Packet-Based Mobile Backhaul

## **RAD's SyncTop-Enabled Cell-Site Gateways and Demarcation Devices**



**data communications**

The Access Company



## Abstract

Clocking data, which has been transmitted natively in TDM networks, requires special attention in new packet switched networks (PSNs) as these are asynchronous by nature and introduce inaccuracies. The following paper explains the need for packet timing and synchronization in mobile backhaul and reviews the most popular methods in use today. It also introduces RAD's revolutionary **SyncToP** platform and the benefits it brings to operators and transport providers in cost-effectively eliminating the risk of service disruptions, impaired cell hand-offs and excessive dropped calls.

## Contents

<i>1</i>	<i>The Need for Synchronization and Timing over Packet (ToP) Solutions.....</i>	<i>2</i>
<i>2</i>	<i>Synchronization and ToP Methodologies.....</i>	<i>3</i>
2.1	Adaptive Clock Recovery (ACR).....	3
2.2	IEEE 1588-2008 (1588v2) .....	3
2.3	Synchronous Ethernet (Sync-E).....	3
2.4	Network Timing Reference (NTR).....	3
<i>3</i>	<i>RAD's SyncToP Platform.....</i>	<i>4</i>
	<i>Conclusion.....</i>	<i>7</i>

# 1 The Need for Synchronization and Timing over Packet (ToP) Solutions

Telecom providers, mobile operators and private network owners everywhere are migrating to NGN (next-generation networks) architecture to benefit from packet transport's ultra-high throughput and substantial cost savings. However, while clocking data has been transmitted natively in TDM networks, new packet switched networks (PSNs) are asynchronous by nature and introduce inaccuracies, such as packet delay variation (PDV) and packet loss – making synchronization the biggest challenge in the migration to Ethernet, IP and MPLS transport.

Packet transport's synchronization challenges are currently affecting mobile services the most, due to the stringent requirements for "SDH/SONET or better" performance levels of such services. Without proper clock transfer solutions, operators and transport providers that are introducing all-IP RANs (radio access networks) and 4G LTE run the risk of service disruptions, impaired cell hand-offs and excessive dropped calls. PSNs therefore require robust clock distribution to all network elements to ensure accurate handover for real-time voice and video services, as well as for data applications. New LTE networks will require frequency as well as phase and time synchronization, not only for TDD (time-division duplex) networks, but also for those utilizing FDD (frequency-division duplex). MBMS (multimedia broadcast multicast system) applications and radio interference between base stations (eNodeBs) are two of the reasons phase accuracy is expected to be mandatory in FDD LTE.

A particular clock accuracy challenge is presented by the increasingly popular trend of backhaul sharing, in which several operators share their access networks or outsource their backhaul services to fixed-line transport providers in an effort to reduce the substantial impact these network have on operating and capital expenses. In such cases, highly accurate, simultaneous clock transfer for multiple clock domains is essential to ensure each operator receives timing data from their own clock source.

## 2. Synchronization and ToP Methodologies

The most popular methods for ensuring synchronization in PSNs include the following:

### 2.1 Adaptive Clock Recovery (ACR)

ACR is a frequency synchronization method in which the clock is distributed over the PSN as a Constant Bit Rate (CBR) TDM pseudowire stream and regenerated at the receiving end using the packet's time-of-arrival information, independently of the physical layer. The clock stream format is a standard TDM pseudowire (SAToP/CESoPSN) flow, delivered in either unicast or multicast modes.

### 2.2 IEEE 1588-2008 (1588v2)

IEEE standard 1588, also known as Precision Time Protocol (PTP), is a frequency, phase and TOD distribution protocol in packet networks, offering high accuracy with nanosecond precision. It is based on timestamp information exchange in a master-slave hierarchy, whereby the timing information is originated at a Grandmaster clock function that is usually traceable to a Primary Reference Clock (PRC) and/or Coordinated Universal Time (UTC). Although it can be implemented end-to-end, support of 1588 by intermediate network elements ("boundary clocks" and "transparent clocks") ensures better performance.

### 2.3 Synchronous Ethernet (Sync-E)

Synchronous Ethernet, defined in ITU-T standards G.8261, G.8262 and G.8264, uses the Ethernet physical layer to accurately distribute frequency, applying clock mechanisms similar to those of SDH/SONET. Unlike higher-layer timing distribution, where clocking information is carried as a flow of packets, Synchronous Ethernet locks the clock of the Ethernet physical layer to a PRC, independently of the data transmission protocols used at higher layers. As Sync-E is a link-by-link frequency distribution scheme, it requires the entire clock distribution path (i.e. all the network nodes involved) to be Sync-E compliant.

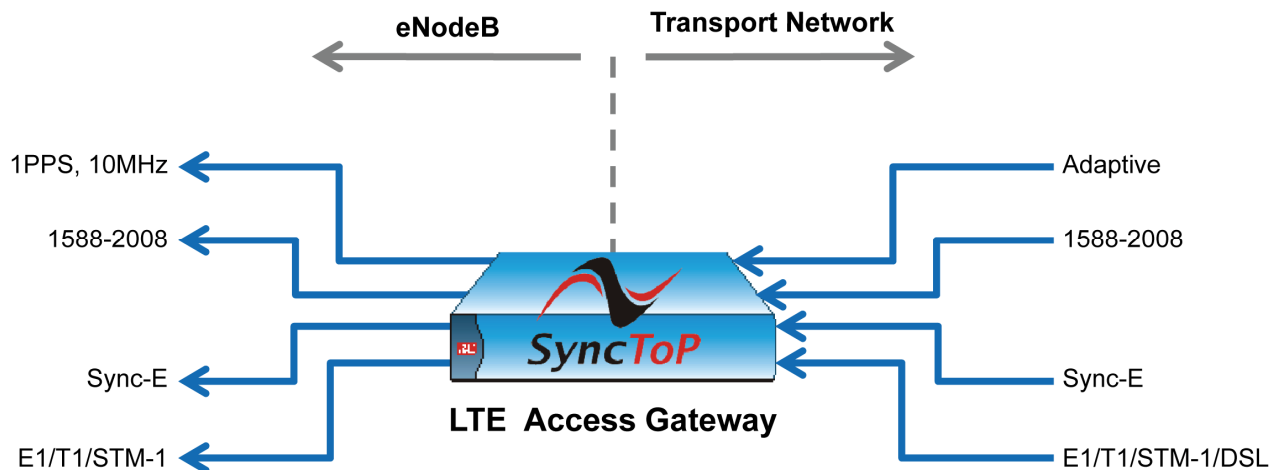
### 2.4 Network Timing Reference (NTR)

NTR is a highly accurate standardized method for frequency distribution in DSL-based Last Mile segments. A network reference clock (i.e. a service clock) is distributed from an NTR-enabled DSLAM to the CPE by mapping its frequency information to the DSL modem transmission. The advantages of NTR lie in its high level of accuracy and in the fact that it eliminates the need for an

expensive synchronization apparatus in the DSL modem/IAD, thereby reducing the overall cost of the solution.

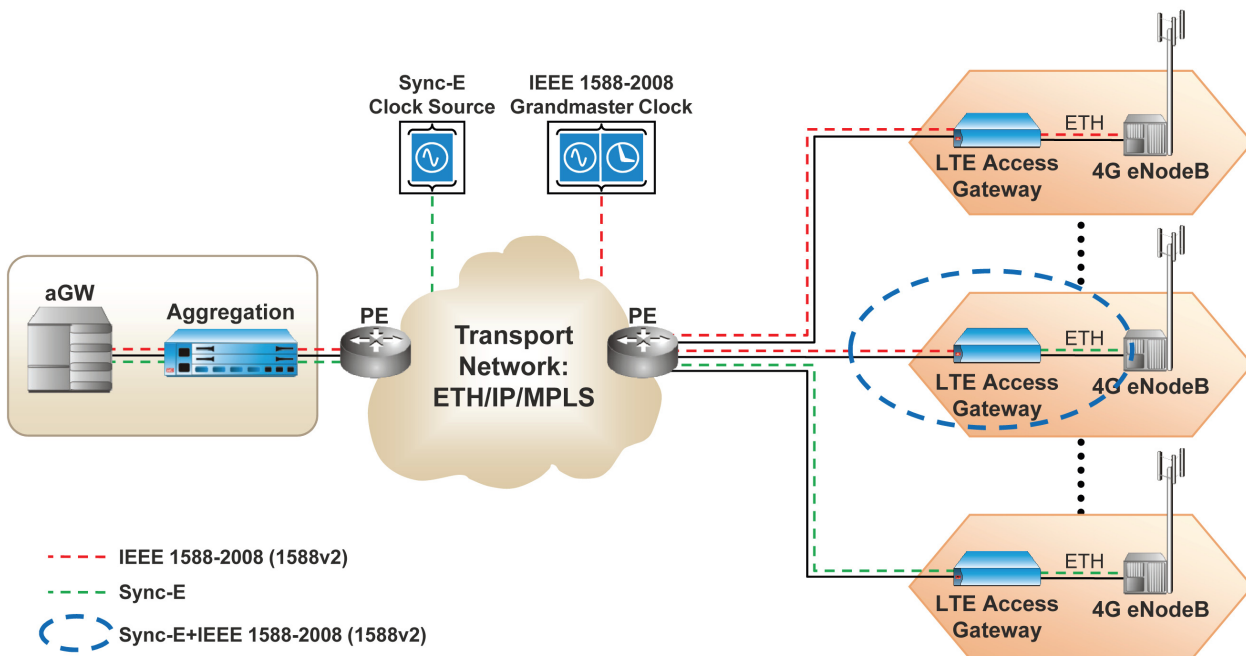
### 3 RAD's SyncToP Platform

RAD is the contributing author of the major standards for timing and synchronization over packet transport, including IEEE 1588-2008 and ITU-T G.8261-G.8266 (G.8261bis), as well as a member of the IETF's TICTOC Work Group. Harnessing its expertise and know-how, RAD has created the **SyncToP** platform of high-performance clock recovery and distribution techniques with powerful frequency, phase and TOD alignment capabilities. These are incorporated into a variety of PSN access gateways and demarcation devices to ensure reliable transmission of 2G, 3G and 4G traffic without the need for costly dedicated hardware or GPS installations. **SyncToP's** proven best-of-breed capabilities offer superior performance and robustness compared to other solutions available in the market.

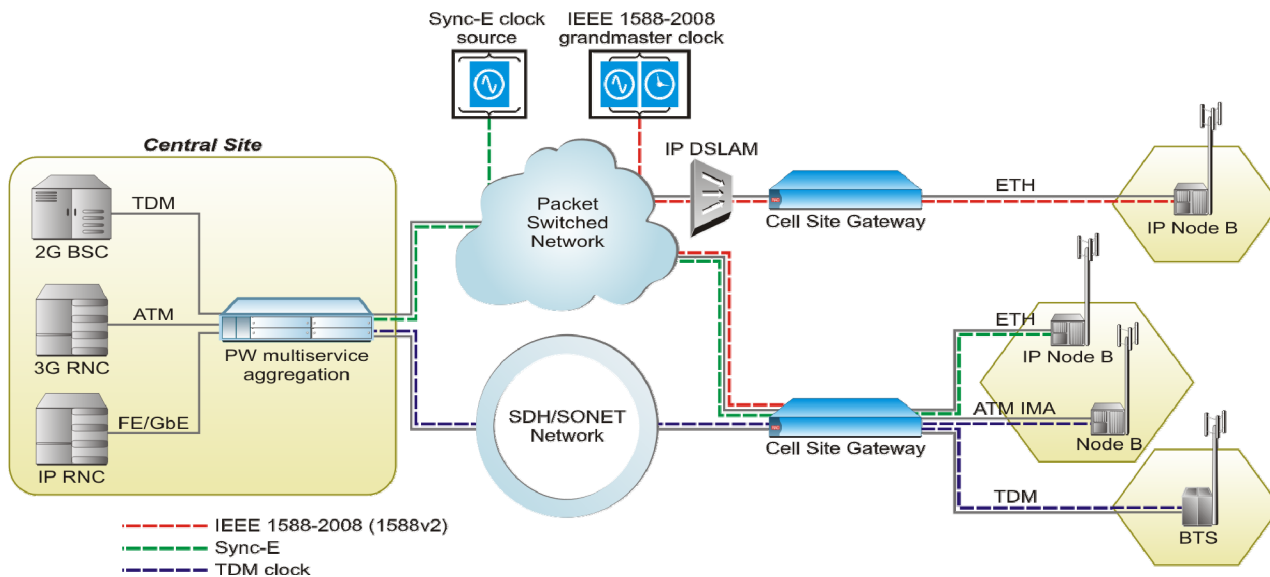


**Figure 1:** Multiple synchronization and Timing over Packet methodologies by a single backhaul gateway

The **SyncToP** suite includes such technologies as IEEE 1588-2008, Synchronous Ethernet, Adaptive Clock Recovery and NTR, the latter implemented in a manner that enables its use even with IP DSLAMs which are not equipped with NTR support. As illustrated in Figure 1, the **SyncToP** platform provides unique flexibility in supporting the simultaneous use of different clock transfer methodologies, for example, employing Sync-E to receive the clock from the network then distributing it to the cell-site using PTP. This provides backhaul suppliers with the ability to match different clocking technologies used by the transport network and the base stations, as well as help them avoid complete network upgrades with new hardware to support Sync-E end-to-end. **SyncToP** also provides a critical service in network segments that do not yet support 1588-2008 or Sync-E, by recovering the clock from an E1/T1 link – still available in most locations – and distributing 1PPS signals to the cell site. The use of different methodologies in various mobile backhaul networks is shown in figures 2 and 3:



**Figure 2:** Synchronization and Timing over Packet in LTE backhaul



**Figure 3:** Accurate clock transfer in multi-generation backhaul networks

In addition, transport providers offering clock distribution as a backhaul service stand to benefit greatly from RAD's **SyncToP**-powered gateways combining timing and synchronization with demarcation capabilities. Aside from their equipment consolidation benefits, these gateways help providers navigate through the intricacies of multi-operator clocking SLAs, including QoS, resource management, OAM and security for the different entities located at the same site.

## Conclusion

The transition to packet-based transport is picking up pace as mobile operators, transport providers and wholesale carriers look to benefit from the higher throughput and lower cost per Mbps these next-generation networks offer. More than any other factor, clocking accuracy is key in ensuring a successful migration, as it enables the delivery of revenue-generating services at the required quality. Incorporating the **SyncToP** platform, RAD's ground-breaking backhaul gateways and demarcation devices minimize the costs associated with packet access timing and synchronization by offering the following value proposition:

- ✓ Ensure service quality at SDH/SONET levels for real-time voice and video over packet
- ✓ Allow high flexibility by bridging different timing and synchronization technologies and eliminate the need for complete network upgrades
- ✓ Reduce CapEx by incorporating synchronization functionalities in the demarcation device/backhaul gateway without the need for dedicated clocking hardware
- ✓ Lower OpEx by optimizing bandwidth utilization for efficient clock transfer
- ✓ Enable wholesale transport providers to introduce backhaul clock distribution services to increase revenues
- ✓ Improve operator and transport provider flexibility with proven interoperability with devices from leading vendors

For more information on RAD's SyncToP solutions, please visit [www.rad-cellular.com](http://www.rad-cellular.com)



[www.rad.com](http://www.rad.com)



**data communications**

The Access Company

**International Headquarters**

RAD Data Communications Ltd.  
24 Raoul Wallenberg St.  
Tel Aviv 69719 Israel  
Tel: 972-3-6458181  
Fax: 972-3-6498250  
E-mail: [market@rad.com](mailto:market@rad.com)  
[www.rad.com](http://www.rad.com)

**North America Headquarters**

RAD Data Communications Inc.  
900 Corporate Drive  
Mahwah, NJ 07430 USA  
Tel: (201) 529-1100,  
Toll free: 1-800-444-7234  
Fax: (201) 529-5777  
E-mail: [market@radusa.com](mailto:market@radusa.com)  
[www.radusa.com](http://www.radusa.com)

The RAD name and logo are registered trademarks of RAD Data Communications Ltd. © 2009  
RAD Data Communications Ltd. All rights reserved. Subject to change without notice. Catalog n  
802444 Version 12/2009