VECTRON INTERNATIONAL
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Helping Customers Innovate, Improve & Grow

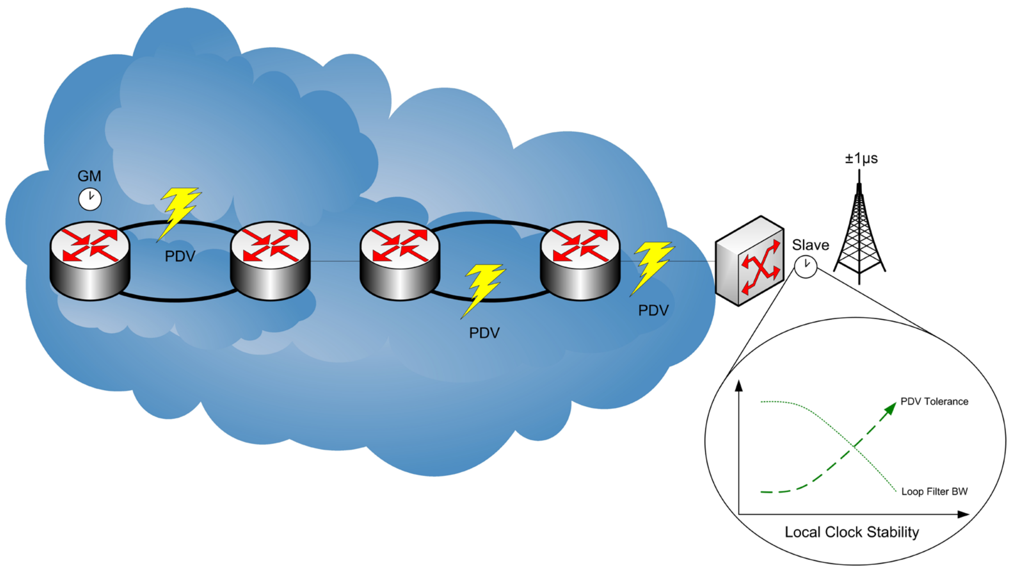
FACT SHEET

1588 Optimized Oscillators

Enhanced Clock Stability for the 1588 enabled network.

In Packet based timing, the prediction, monitoring and management of Packet Delay Variation (PDV) is complex, challenging, potentially costly and still open to random 'network noise' events.

Placing a predictable, stable and cost effective local clock at the client node can greatly improve the odds in dealing with network noise – increased client robustness allows a timing to be deployed across larger and less managed networks, reducing the overall cost of a timing solution.



As Local Clock stability increases, the loop filter bandwidth can be reduced and PDV tolerance goes up

Industry Need

- An all IP/Ethernet network to increase bandwidth while reducing costs.

The Challenge

- Communications applications require synchronization.
- Delivering synchronization over IP networks is a challenge.
- PTP (Precision Timing Protocol, or IEEE-1588-2008) is a promising approach to this.
- Traditional oscillator performance limits the effectiveness of PTP.

The Solution

- Oscillators optimized for performance in PTP applications.
- The only oscillators specifically designed and tested for use in PTP clock applications.

1588 derived frequency reference challenges.

Packet based timing technologies work on the two way exchange of timing information between a Master Clock and Slave (or Client) Clock. The 1588 protocol works on the assumption that this two way exchange is symmetric (i.e. it expects that the Packet Delay from Master to Slave and Slave to Master is the same). However, in the majority of wide area networks this is not the case and the phenomena of Packet Delay Variation (PDV) introduces noise into the Client clock. Without severely limiting the scale of the network or introducing complex management schemes, deriving accurate frequency and phase information from the packet network is a challenge.

Timing Requirements

Application	Time/Phase synchronization accuracy
CDMA2000 (3GPP2 C.S0010-B, 3GPP2 C.S0002-C)	+/- 3µs with respect to UTC* (during normal conditions) +/- 10µs of UTC (when the time sync reference is disconnected)
W-CDMA (TDD mode) (3GPP TS 25.402)	2.5µs phase difference between Base Stations
TD-SCDMA (TDD mode) (3GPP TR 25.836)	3µs phase difference between Base Stations
LTE (TDD) (3GPP TS 36.133)	3µs time diffference between Base Stations (small cell). 10µs time difference between Base Stations (large cell)
MBSFN (e.g. over LTE)	< +/- 1µs with respect to a common time reference (continuous timescale)
WiMAX (TDD mode) (IEEE 802.16)	Depends on several parameters. Ranges from +/-0.5µs to +/-5µs

**See definitions at end of document*

1588 Timing Solutions

There are a number of approaches described in the 1588 protocol that can be taken to delivering timing over a packet network. In broad terms these approached can be divided into the Ordinary Clock approach and the Transparent Clock approach.

Ordinary Clock approach: In the Ordinary Clock approach the timing information is sent from the Master clock to the Slave clock without adjustment being made to the time stamp information by intervening nodes – routers in the path between the master and slave do not tell the slave anything about their behavior. The advantage of this approach is that the disruption to the existing network is minimal and service providers can deploy 1588 over an existing network – A possible disadvantage is that the Slave needs to be robust in the presence of PDV.

Transparent Clock approach: In the Transparent Clock approach the timing information is updated as it travels from the master to the slave – routers in the path between the master and slave can make adjustments to the packet to tell the slave about their behavior. The advantage of the Transparent Clock is that the deployment can self-correct network disruptions far more easily – a disadvantage is that service providers are faced with the possibility of expensive 'forklift upgrades' of existing networks.

Vectron Oscillators for 1588

Vectron matches the stability characteristics of its oscillators with the requirements of 1588 client clocks – this is done by design, but also through a system level verification of the oscillators' suitability in the target application. Choosing oscillators for 1588 applications is in many ways similar to selecting devices to support SONET/SDH 'stratum' level applications. However the role of PDV and any corresponding packet filtering used in a Packet Equipment Clock (PEC) needs to be considered also, since the system loop filter bandwidth is not necessarily pre-defined in the same way as SONET/SDH.

Vectron Oscillators optimized for 1588			
Parameter	OX-402	OX-222	OX-202
Frequencies	10MHz, 12.8MHz, 20MHz	10MHz, 12.8MHz, 20MHz	10MHz, 12.8MHz, 20MHz
Package	13 x 20mm Through-hole	22 x 25mm SMT	25 x 25mm Through-hole
Holdover Stability	<10ppb	<10ppb	<10ppb
Drift	<1ppb	<0.8 ppb	<0.75ppb
Wander Generation MTIE[1]			
1s	0.2 ns	0.2 ns	0.2ns
10s	2.0 ns	2.0 ns	1.6ns
100s	10 ns	10 ns	12ns
1000s	40 ns	40 ns	34ns
Wander Generation TDEV[1]			
1s	0.015 ns	0.015 ns	0.001ns
10s	0.13 ns	0.13 ns	0.05ns
100s	1.5 ns	1.5 ns	0.8ns
1000s	5.0 ns	5.0 ns	3.5ns

Notes - 1. Wander Generation per GR1244, system performance when locked through a 1mHz loop bandwidth. See typical data in datasheets.

Definitions

PTP - Precision Timing Protocol - Generic name for the protocol described in IEEE standard 1588-2008
PDV - Packet Delay Variation - A key source of time error in packet based timing mechanisms
PEC - Packet Equipment Clock - Described in G.8263 and a model of how a 1588 clock derives timing.
UTC - Coordinated Universal Time, Transmitted by GPS
Holdover - Holdover stability represents the maximum change in the clock frequency over time after the loss of all frequency references, and takes temperature as well as drift into account.
Drift - Drift is a measure of how a clock's frequency accuracy (or offset) changes with time. Drift does not take temperature effects into account.
MTIE - The maximum time interval error, MTIE, is a measure of the maximum time error of a clock over a particular time interval.
TDEV - TDEV, the root of time Allan Variance TVAR, is a measure of time stability

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