syn1588 ®

Version 1.17.0 - February 2024

Abstract

This application note answers the questions that frequently arise when using the syn1588® PCIe NIC or the syn1588® Dual NIC for the first time.

Ordering

Where to buy syn1588®

We sell our syn1588® products worldwide. For this there are selected qualified distributors that serve a specific region. Please check our web site for the most recent list:

https://www.oreganosystems.at/contact/distributors

For all other regions, one may directly order the syn1588® products at Oregano Systems. Simply send an email to contact@oregano.at or sales@oregano.at and you'll receive quotations for your chosen syn1588® products.

Where to start

Both the syn1588® PCIe NIC and the syn1588® Dual NIC come with a wooden USB stick. This USB stick holds not only all required software, drivers and documentation but also the syn1588® Live System. Thus, one just needs to insert the card into any PCIe slot and boot the computer using this USB stick. One does not have to install any software this way.

Caution! Please observe the usual ESD precautions when handling the syn1588® PCIe NIC and the syn1588® Dual NIC.

For more information we suggest to start with the syn1588® PCIe NIC Quick Start Guide:

https://www.oreganosystems.at/application/files/2716/7385/3435/an004_syn1588nic_quick_start_guide.pdf

If one sets up the first real life PTP network the following application note is a useful guide for debugging typical PTP setup issues:

https://www.oreganosystems.at/application/files/1516/4259/5166/an003_ptp_analysis.pdf

Finally there is the datasheet for the syn1588® PCIe NIC as a reference for all kinds of specifications:

https://www.oreganosystems.at/application/files/2516/7446/7338/syn1588_pcie_nic_ds.pdf

There is also a datasheet for the syn1588® Dual NIC available:

https://www.oreganosystems.at/application/files/7616/4093/8591/syn1588_dual_nic_ds.pdf

All the details of using the software and utilities are described in the syn1588® User Guide which is again available on the wooden USB stick (directory "doc", file name "ug_syn1588.pdf").

Software

Is there an API/SDK?

Yes, there is an API available. Actually there are two of them. The syn1588® API is used to access the syn1588® hardware functions while the Shared Memory API is used for controlling and monitoring the operation of the syn1588® PTP Stack. For the latter API there is an application note available. Both APIs as well as code examples for frequent use cases are delivered with the syn1588® PCIe NIC or syn1588® Dual NIC on the wooden USB stick. Check the directory "sw/api". It holds two ZIP files for each of the APIs.

Can the syn1588® PCIe NIC act as a PTP Master?

Yes, the syn1588® PCIe NIC can act as a standard PTP Master. Without any additional information the syn1588® PCIe NIC will be free-running using time 0 (i.e. January 1st 1970) at startup. One can pre-load the hardware clock with any time prior starting the syn1588® PTP Stack. Additionally one can connect a GPS receiver to provide the current absolute time. Please note, we strongly recommend to use the high-stability OCXO oscillator option when using the syn1588® PCIe NIC in PTP Master mode.

How to run the syn1588® PCIe NIC as a PTP Master?

The PTP Master/Slave function is determined by the syn1588® PTP Stack.. By default the BMCA algorithm defined in the IEEE1588 standard is used to determine whether the syn1588® PCIe NIC acts as PTP Master or PTP Slave. The user can request the card to act as PTP Master using the "-C" command line option. Here is a simple example:

```
./ptp -i <your network interface> -C M_EXT
```

One has to replace "<your network interface>" with the interface specification of the syn1588® PCIe NIC in your node. Note, if multiple PTP Master are detected in your network (using the same PTP ClockID) the IEEE1588

standard defined procedure is used to determine, which PTP Master shall remain active while the remaining either switch to PTP Slave state or PTP Master in Holdover state.

How to run the syn1588® PCIe NIC as a PTP Slave?

The PTP Master/Slave function is determined by the syn1588® PTP Stack.. By default the BMCA algorithm defined in the IEEE1588 standard is used to determine whether the syn1588® PCIe NIC acts as PTP Master or PTP Slave. The user can request the card to act as PTP Slave using the "-C" command line option. Here is a simple example:

```
./ptp -i <your network interface> -C S
```

One has to replace "<your network interface>" with the interface specification of the syn1588® PCIe NIC in your node. Note, if no PTP Master (using the same PTP ClockID) is found on the network the card will remain in the Listening state as defined by the IEEE1588 standard.

Can the syn1588® PCIe NIC act as PTP Master support slaves with 1-step and 2-step?

The syn1588® PCIe NIC supports both 1-step and 2-step operation. If a syn1588® PCIe NIC is configured to act as PTP Master either 1-step or 2-step PTP Slaves can be supported. One can mix 1-step and 2-step PTP Slaves on the same PTP Master just under certain conditions:

a) 1-step is IPv4 and 2-step is IPv6 mode (or vice versa)
b) both 1-step and 2-step use the same IP version but have to use different sub nets.
c) both 1-step and 2-step use VLAN but different VLAN addresses
d) either 1-step or 2-step use VLAN while the other doesn't

Solution a.) to d.) require two different PTP instances. The PTP instance using 1-step mode has to use the standard Ethernet MAC timestamping unit while the 2-step mode uses the user timestamping unit in the syn1588®Clock_M. This can be configured with configuration files only.

Hardware

Does syn1588® synchronize my system clock?

PTP in general synchronizes a local (high accuracy) hardware clock which is definitely not any of the standard system clocks present on a PC's or server's motherboard. There are several reasons for this:

- the system clock on the motherboard uses cheapest oscillators. Their frequency varies with any physical parameter to a great extend

- the system clock on the motherboard cares about accuracy in terms of fractional seconds

- the system clock on the motherboard offers limited clock rate control

- the system clock on the motherboard uses human readable time notation while PTP uses TAI in seconds, nanoseconds and fractional nanoseconds

- the system clock on the motherboard offers a time resolution of microseconds (in best case); the syn1588® PCIe NIC uses 2^{-16} nanoseconds

Any PTP system uses a hardware clock in the NIC. The syn1588® PCIe NIC has been specifically designed for high accuracy clock synchronization; there is a dedicated high-quality, high-stability oscillator and a special circuit structure to avoid any disturbances of this local oscillator. Only by using this hardware clock structure and our high-quality, high-stability oscillators one can achieve a synchronization accuracy of 5 ns and better.

Together with the syn1588® PCIe NIC one will receive a bunch of utilities. One of the them - lSync - allows you to synchronize the system clock to the high accuracy PTP hardware clock. Of course the accuracy one will end up with when using the system clock will be degraded compared to the hardware clock; but that's in the nature of the system clock.

Since the syn1588® Dual NIC offers two hardware clocks any of the two may be selected to synchronize the system clock.

Which IO functions are available at the SMA connectors?

The user is free to choose any of the available IO functions for any of the four SMA connectors. The syn1588® PCIe NIC offers two SMA connectors at the PCI bracket; two more are internally available if one ordered the "Plug" option of the syn1588® PCIe NIC. The following list shows the IO functions which may be selected for output:

- disabled (output tri-state, used as input)
- period2_o signal of syn1588® Clock_M (Period Light function)
- period3_o signal of syn1588® Clock_M (Period Light function)
- period0_o signal of syn1588® Clock_M
- period1_o signal of syn1588® Clock_M
- trigger0_o signal of syn1588® Clock_M
- trigger1_o signal of syn1588® Clock_M
- 1pps_o signal of syn1588® Clock_M
- IRIG-B output signal of syn1588® Clock_M
- Rx timestamp strobe (for debugging)
- TX timestamp strobe (for debugging)
- filtered period1_o via external jitter cleaner PLL
- 1pps input from GPS (syn1588® VIP Rev3 only)
- Framesync output

Additionally, any of the four SMA connectors may be selected for an input function as well. In this case the output function is not available.

- event0_i signal of syn1588® Clock_M
- event1_i signal of syn1588® Clock_M
- IRIG-B input signal of syn1588® Clock_M

For the syn1588® Dual NIC there are two clock functions that have to share the SMA pins. The rules are simply as follows:

- For every SMA connector output signal only one of the two syn1588® Clock_M IP cores shall be configured via its IOMATRIX register to drive a signal.
- In case that both syn1588® Clock_M IP cores try to drive the identical SMA output the second (line B) interface will overwrite the function.

Can I connect a GPS receiver?

Yes, one can connect a GPS receiver to the syn1588® PCIe NIC to provide an absolute time reference. For this a 1PPS signal has to be connected to any of the SMA connectors of the syn1588® PCIe NIC. Additionally a serial interface (UART) has to be connected to the local node. Note, the syn1588® PCIe NIC does not offer such a serial interface. There is an application note that describes all the details of connecting a GPS receiver to the syn1588® PCIe NIC.

https://www.oreganosystems.at/application/files/3916/4259/5088/an009_gps_receiver.pdf

How-To Generate a 1 PPS Signal

As soon as the driver is properly installed for the syn1588® PCIe NIC a 1 PPS output signal is automatically generated. Per default, the 1PPS signal is presented on the SMA connector X4. That's the connector next to the network interface connector at the PCI bracket. One may use the syn1588 utility to change the SMA connector driving the 1PPS signal.

How-To Generate a Frequency

There are two PERIOD functions within the syn1588® PCIe NIC which can generate periodical signals. One may use the syn1588 utility to specify the required frequency to be generated as well as the SMA connector to be used for the output. There is an application note available that explains step-by-step the required actions for generating frequency signals:

https://www.oreganosystems.at/application/files/5716/7385/3535/an008_jitter_clean_pll.pdf