




Abstract

This application note describes the process of running the Precision Time Protocol (PTP) as defined in IEEE 1588-2008 on a PC or server using a syn1588[®] PCIe NIC. It highlights the basic steps required to install and use the syn1588[®] PCIe NIC as well as references to the syn1588[®] User Guide (indicated by this symbol .

Prerequisites

- A syn1588[®] PCIe NIC.
- A PC with a free PCIe slot.
- The wooden USB-Stick bundled with your syn1588[®] PCIe NIC containing the syn1588[®] PTP software and all accompanying drivers and documents within a syn1588[®] Linux Live System.
- In case the software is to be installed on an existing operating systems rather than using the syn1588[®] Linux Live System administrator rights are required.


What about the syn1588[®] Dual NIC

The basic installation procedure for the syn1588[®] Dual NIC is identical to the one for the syn1588[®] PCIe NIC. The main difference is that the syn1588[®] Dual NIC currently just supports Linux OS.

Basic Installation of the syn1588[®] PCIe NIC

To set up the syn1588[®] PCIe NIC please start with the following steps:

- Power off your PC.
- Insert the syn1588[®] PCIe NIC into an empty PCIe slot. Use an appropriate slot that supports PCIe x1 cards.
- Connect the syn1588[®] PCIe NIC to a network or to another PC using a standard Ethernet cable (or optical fiber in case of the SFP version of the syn1588[®] PCIe NIC).

There are two different ways of continuing: Either use the bootable syn1588[®] Linux Live System contained on the USB Stick provided with the syn1588[®] PCIe NIC or you could install the software together with the drivers onto an existing Windows/Linux PC. If there are any problems during the installation of the syn1588[®] PCIe NIC, please consult the syn1588[®] User Guide at chapter  4.4.

Using the syn1588[®] Linux Live System

The syn1588[®] Linux Live System starts a dedicated Linux (Ubuntu 16.04, 32 bit) with all drivers and utilities pre-installed. Please make sure, that the PC you are using is able to boot from an USB stick; you might have to check the BIOS settings for this.

Insert the USB stick into your computer and select the appropriate boot option. After the boot procedure has been completed successfully you will see an Ubuntu desktop. There are several icons on the desktop of the syn1588[®] Linux Live System. To run PTP using the syn1588[®] PCIe NIC double-click one of the icons on the desktop:

- “PTP-Stack in Master mode” to start a syn1588[®] PTP master
- “PTP-Stack in Slave mode” to start a syn1588[®] PTP slave

Installing the driver on your PC


The first step which has to be completed after powering up your PC is the installation of the device driver. Please note, that this step usually needs Administrator-Rights on Windows, root-rights on Linux respectively.

There are tools to verify the proper operation of the syn1588[®] PCIe NIC hardware. This allows to deal with systems that behave somewhat different from standard systems. These tools can be found on the provided USB-Stick or other storage medium. If you are able to see an additional network adapter in the system you can proceed.


Installing the device driver in Linux

For a Linux operating system open a root shell, browse to the Linux driver-directory “/sw/drv/linux” and execute:

```
> make
> make modules_install
> modprobe SyncDriver
```

Note, that all corresponding source files for your kernel have to be installed prior compiling the driver. For details and information about a permanent installation, refer to  4.4.1.

Installing the device driver in Windows

If not already prompted to install a new device, simply browse to the Control Panel and open the Device Manager. Select the new device, which may be listed as “unknown device” and update the drivers. Manually select “syn1588.inf” in the device driver folder “/sw/drv/windows” on the provided syn1588® USB Stick. After successful installation, the syn1588® PCIe NIC should be listed at the section “network cards” in the Windows device manager or System Control. For troubleshooting or further information refer to  4.4.2.

In case of installation issues

In case the installation procedure of the device driver software fails please check this chapter that describes how to fix frequently known issues.

Basic Presence Check of the syn1588® PCIe NIC

First step is to check for the presence of the syn1588® PCIe NIC in the device list of the computer. If this check fails the device is not recognized by the PC's BIOS. Reasons for this are either an inappropriate PCIe slot or the card is not correctly inserted. Please power-off your PC prior checking the proper connection.

Linux

Run the command “lspci | grep Altera” from any terminal. The command shall return a line like the following:

```
> lspci | grep Altera
03:00.0 Ethernet controller: Altera Corporation Device 1000 (rev 03)
```

If the command returns no entry the BIOS had not recognized the syn1588® PCIe NIC. Check that the syn1588® PCIe NIC had been properly inserted in an appropriate PCIe slot.

Windows

Browse to the Control Panel and open the Device Manager. There should be a new network interface card listed for the syn1588® PCIe NIC. In rare cases the card shows up as an unknown device. If no such device is present the BIOS had not recognized the syn1588® PCIe NIC.

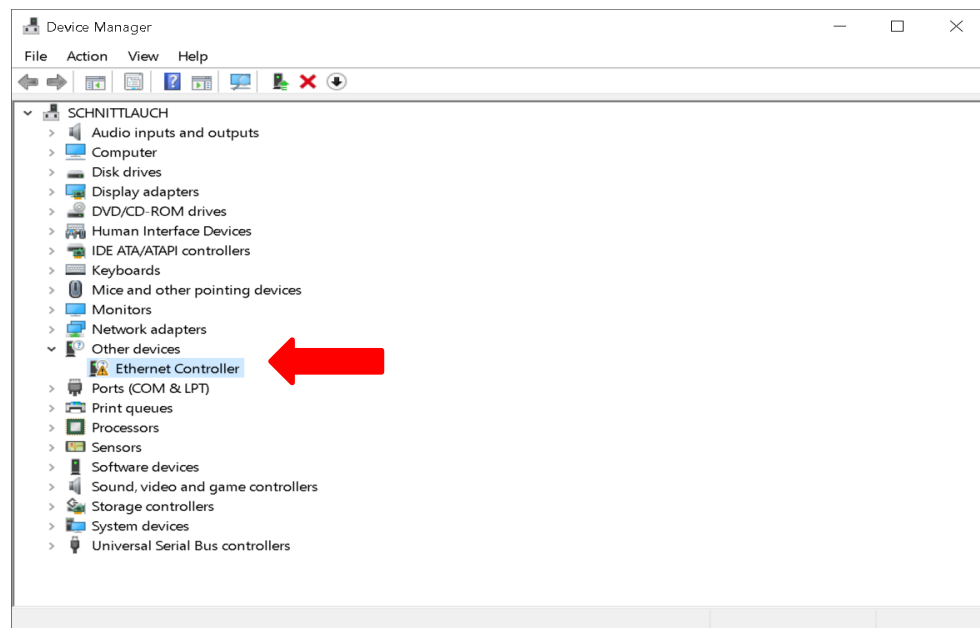


Figure 1: Device manager: Other Devices

Driver Check

If the syn1588[®] PCIe NIC had been successfully recognized by the PC's BIOS one has to check whether the device driver had been successfully installed.

Linux

For Linux there are actually two device drivers that have to be installed:

- syn1588nic
- SyncDriver

The "SyncDriver" has to be loaded after the "syn1588nic" driver. One can use the "lsmod" command to check for the presence of these drivers:

```
> lsmod |grep syn1588
syn1588nic      53248  1 SyncDriver
mii             16384  2 r8169,syn1588nic
> lsmod |grep Sync
SyncDriver     20480  0
syn1588nic     53248  1 SyncDriver
```

If the drivers do not show up they are not properly installed. Please run the “make” command in the driver directory to compile and load the drivers. Please carefully check the output of this “make” command. There is a “README” file included in the driver directory which describes this make process.

```
apps/drv/linux:> make modules_install
trying to build driver with kernel source /usr/src/linux
make[1]: Entering directory '/usr/src/linux-headers-4.15.0-38-generic'
CC [M] /opt/oregano/release_20191121/sw/drv/linux/fake_fifo.o
CC [M] /opt/oregano/release_20191121/sw/drv/linux/syn1588nic_main.o
CC [M] /opt/oregano/release_20191121/sw/drv/linux/syn1588nic_pci.o
LD [M] /opt/oregano/release_20191121/sw/drv/linux/syn1588nic.o
CC [M] /opt/oregano/release_20191121/sw/drv/linux/SyncDriver.o
Building modules, stage 2.
MODPOST 2 modules
CC /opt/oregano/release_20191121/sw/drv/linux/SyncDriver.mod.o
LD [M] /opt/oregano/release_20191121/sw/drv/linux/SyncDriver.ko
CC /opt/oregano/release_20191121/sw/drv/linux/syn1588nic.mod.o
LD [M] /opt/oregano/release_20191121/sw/drv/linux/syn1588nic.ko
make[1]: Leaving directory '/usr/src/linux-headers-4.15.0-38-generic'
make[1]: Entering directory '/usr/src/linux-headers-4.15.0-38-generic'
INSTALL /opt/oregano/release_20191121/sw/drv/linux/SyncDriver.ko
At main.c:160:
- SSL error:02001002:system library:fopen:No such file or directory:
../crypto/bio/bss_file.c:72
- SSL error:2006D080: BIO routines: BIO_new_file: no such file:
../crypto/bio/bss_file.c:79
sign-file: certs/signing_key.pem: No such file or directory
INSTALL /opt/oregano/release_20191121/sw/drv/linux/syn1588nic.ko
At main.c:160:
- SSL error:02001002:system library:fopen:No such file or directory:
../crypto/bio/bss_file.c:72
- SSL error:2006D080: BIO routines: BIO_new_file: no such file:
../crypto/bio/bss_file.c:79
sign-file: certs/signing_key.pem: No such file or directory
DEPMOD 4.15.0-38-generic
make[1]: Leaving directory '/usr/src/linux-headers-4.15.0-38-generic'
```

Note, some Linux versions require a signed device driver. The “SSL errors” messages marked with red color in the example output above are caused by the fact that the driver is not signed or properly signed by the Linux OS which requires a signed driver. Follow the step-by-step instructions of the “README” file included in the driver directory to generate such a signed driver.

The following output shows the correct loading of the driver:

```
sw/drv/linux:> make modules_install
trying to build driver with kernel source /usr/src/linux
make[1]: Entering directory `/usr/src/linux-headers-3.13.0-32-generic'
CC [M] /opt/oregano/release_20191121/sw/drv/linux/fake_fifo.o
CC [M] /opt/oregano/release_20191121/sw/drv/linux/syn1588nic_main.o
CC [M] /opt/oregano/release_20191121/sw/drv/linux/syn1588nic_pci.o
LD [M] /opt/oregano/release_20191121/sw/drv/linux/syn1588nic.o
CC [M] /opt/oregano/release_20191121/sw/drv/linux/SyncDriver.o
Building modules, stage 2.
MODPOST 2 modules
CC /opt/oregano/release_20191121/sw/drv/linux/SyncDriver.mod.o
LD [M] /opt/oregano/release_20191121/sw/drv/linux/SyncDriver.ko
CC /opt/oregano/release_20191121/sw/drv/linux/syn1588nic.mod.o
LD [M] /opt/oregano/release_20191121/sw/drv/linux/syn1588nic.ko
make[1]: Leaving directory `/usr/src/linux-headers-3.13.0-32-generic'
make[1]: Entering directory `/usr/src/linux-headers-3.13.0-32-generic'
INSTALL /opt/oregano/release_20191121/sw/drv/linux/SyncDriver.ko
Can't read private key ←
INSTALL /opt/oregano/release_20191121/sw/drv/linux/syn1588nic.ko
Can't read private key ←
DEPMOD 3.13.0-32-generic
make[1]: Leaving directory `/usr/src/linux-headers-3.13.0-32-generic'Note
```

The “Can’t read private key” warnings refer to the private key Ubuntu uses to sign kernel modules. Thus, one cannot have access to this key. This note can be safely ignored; it will not affect the driver’s functionality.

If the drivers had been successfully installed one can check the respective boot messages in the system log. For this enter the command “dmesg | grep syn1588”. One shall see that first the “syn1588nic” driver is loaded followed by the “SyncDriver”.

```

> dmesg |grep syn1588
[ 97.072733] Oregano Systems syn1588(R) NIC Device Driver (syn1588nic)
$Revision: 1.11-0-gba29ad0 $
[ 97.072766] syn1588nic: allocating device resources.
[ 97.072934] syn1588nic: device resources (IRQ #16, I/O 0xECEF0000
(65536)) detected.
[ 97.072958] syn1588nic: remapped memory I/O region to address
0xF86F0000.
[ 97.072959] syn1588nic: registered PCIe-NIC adapter 0000:03:00.0.
[ 97.072970] syn1588nic: PCI-NIC MAC version 3148, build 840.
[ 97.072971] syn1588nic: Found MAC with timestamper, FakeFifo enabled
[ 97.072974] syn1588nic: Using burst lenght: 32
[ 97.072979] syn1588nic: 0000:03:00.0: read permanent HW MAC address
00:1E:C0:85:DE:2B
[ 97.072980] syn1588nic: 0000:03:00.0: using MII managment data clock
4807 kHz (div.: 26).
[ 97.073081] syn1588nic: 0000:03:00.0: could not detect validated PHY!
[ 97.073082] syn1588nic: 0000:03:00.0: scanning for PHY on ID 0-31.
[ 97.073132] syn1588nic: 0000:03:00.0: detected PHY (0x00221622) with
ID 0x00.
[ 97.074875] syn1588nic: eth1: Grp_list_head          7eadf2e9
[ 97.076448] syn1588nic 0000:03:00.0 enp3s0: renamed from eth1
[ 97.093437] syn1588nic: detected syn1588(R) Clock version M234.
[ 97.093440] syn1588nic: req_value 11, value 34
[ 97.093448] syn1588nic: configured clock frequency: 125000 kHz.
[ 97.093449] syn1588nic: setting initial clock step size to 8.0 ns.
[ 97.093506] syn1588nic: detected syn1588(R) PCI-NIC revision 3
(enp3s0).
[ 97.093507] syn1588nic: rev id: 3 - 3
[ 97.093508] syn1588nic: This is a rev 3 NIC, programming DAC
[ 97.096284] Oregano Systems syn1588(R) Clock Synchronization Driver
(SyncD) $Revision: 3990 $
[ 97.096291] syn1588nic: device callback (0x76a7b0f3) registered.
[ 97.183374] syn1588nic: Adapter Rev. 3 passthru mask: fff00000
[ 97.195475] syn1588nic 0000:03:00.0 enp3s0: link down

```

Windows

In case the device is not visible first right click on network adapters and scan for hardware changes. A new network adapter named “SYN1588 PCIe Ethernet Adapter” shall appear.

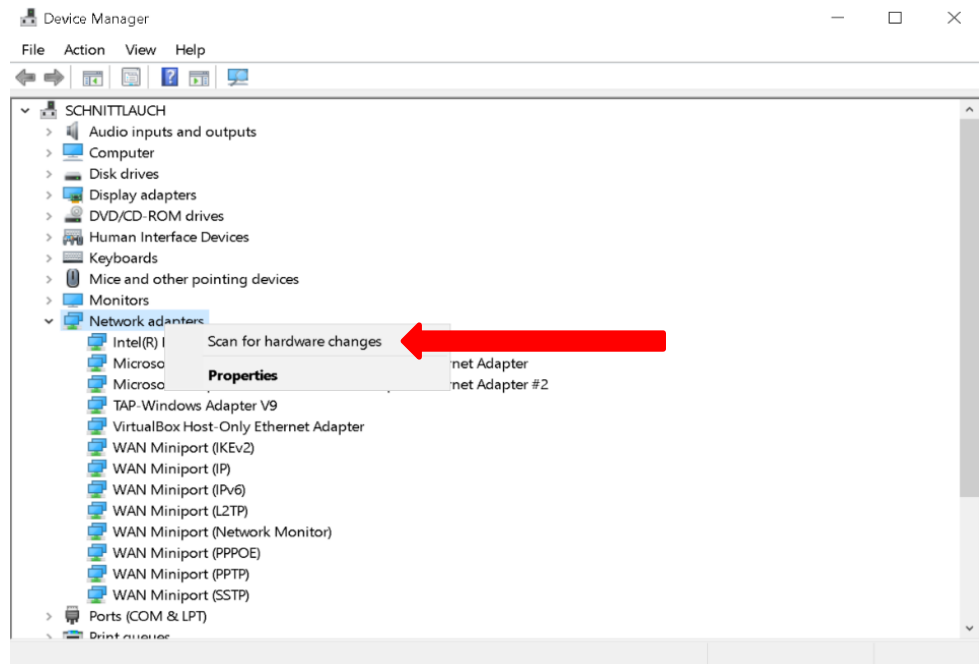


Figure 2: Device manager: scan for network adapters

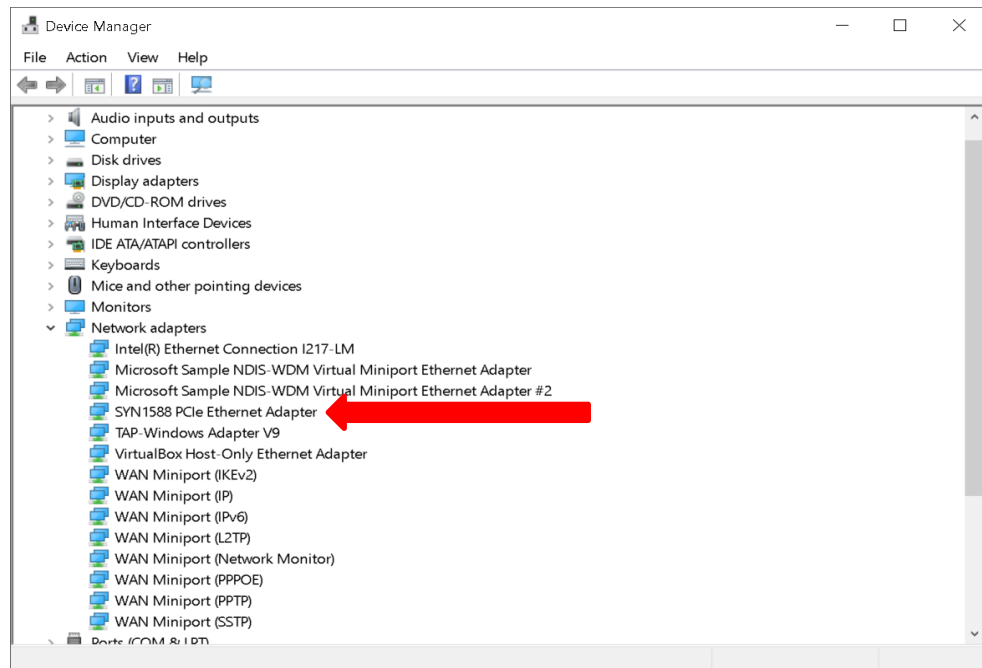


Figure 2.1: Device manager: new network adapter

To access more information or update the device driver travel to the menu “Properties” and in the dialog box select the “Driver” tab. Under this section one can select “Driver Details” to find out more details about the installed driver files or to “Update Driver” to update the installed device driver.

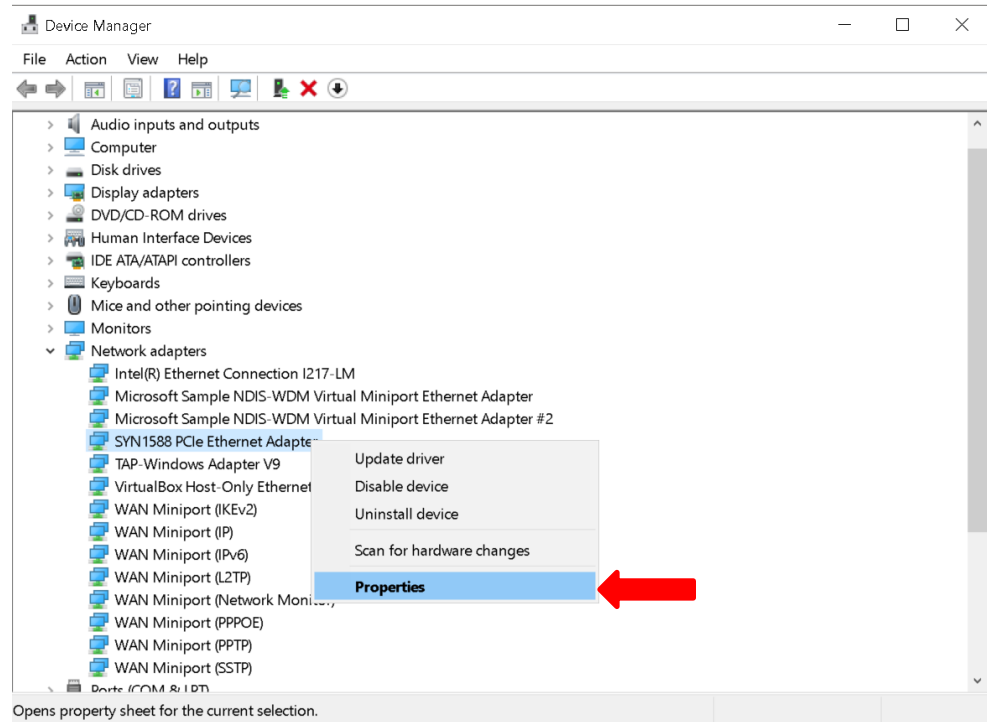


Figure 2.2: Device manager: syn1588® PCIe NIC

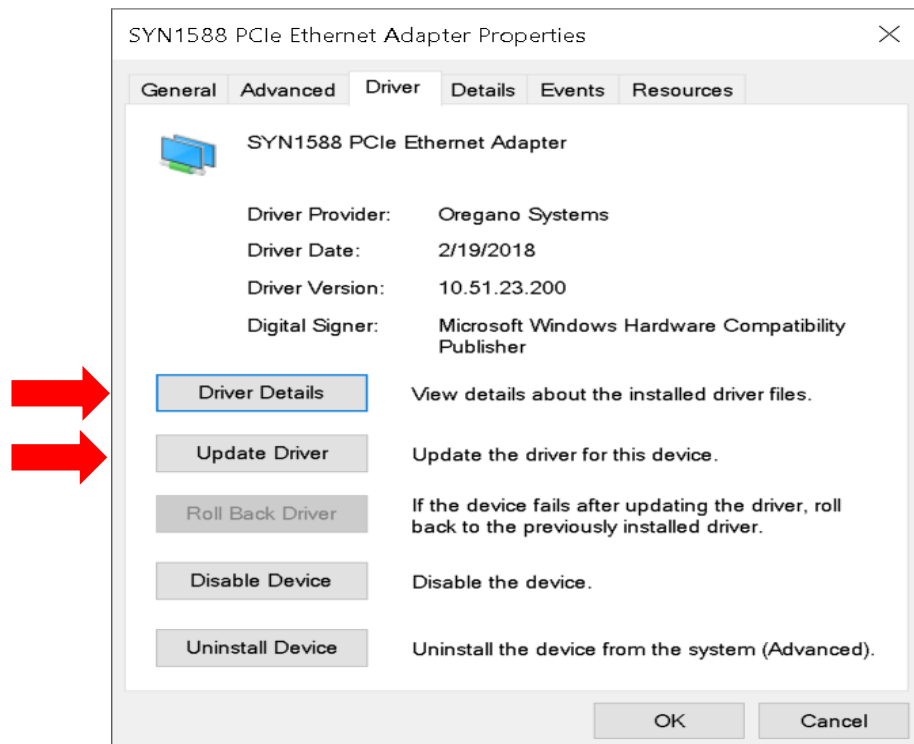


Figure 2.3: syn1588® PCIe NIC: Properties

An alternate way to check if the driver had been installed, is to enter in the command prompt the command “driverquery | findstr syn1588”. No administrator rights are needed. This should bring up the syn1588® driver installed on the system.

```
> driverquery | findstr syn1588
Module Name  Display Name          Driver Type  Link Date
=====
syn1588      SYN1588 PCIe Ethernet Kernel        2/19/2018 10:51:12 AM
```

If this output message is not received the installation of the driver was not successful. Please re-install the driver as shown in the previous steps or refer to the tutorial “How to install a driver in Windows for a syn1588® PCIe NIC” that can be found on our [website](#).


First Steps with your installed syn1588® PCIe NIC

The easiest way to use the syn1588® PTP Stack and other tools is the command line or shell. Please ensure your shell-session has sufficient rights. For Windows an administrator-command line, and for Linux a root-shell is recommended.

As a first step you need to ensure that the syn1588® PCIe NIC has a valid IP-address assigned to it either via DHCP or manual configuration. For Windows write down this IP-address (i.e. 192.168.0.123) for further reference. For Linux you require the adapter name (i.e. eth3).

First change to the directory on the USB stick where the mentioned utilities are located: “/sw/apps/windows” or “/sw/apps/linux”.

Starting the syn1588 Utility

The syn1588 utility is used to control and check several functions of the syn1588® PCIe NIC. For more information about the syn1588 utility please refer to the syn1588® User Guide  7.1.

Linux

```
> cd sw/apps/linux
> ./syn1588
```

The output of the syn1588 Utility on Linux will look like this example output:

```
syn1588(R) Driver Interface
Build date: Apr 19 2019 - V 1.8-4 Rev g274ca2e
Copyright (c) Oregano Systems - Design & Consulting GesmbH 2005-2018
Confidential unpublished data - All rights reserved

Syn1588Ifc requires at least:
- linux driver version 1.4-15-g05b7283
- windows driver version 10/05/2017, 10.9.16.182
Syn1588Impl: Device /dev/syncD0 found
syn1588(R) Hardware Clock M 2.3.4 f=125000000 Hz
Selected syn1588(R) card 0
>
```

Version and status information about the tool and your syn1588® PCIe NIC is shown, if everything was set up correctly. Additionally, one may enter the command “build” on the prompt of the syn1588 Utility to get even more information on the syn1588® PCIe NIC.

If any problems occur, please ensure the previous steps were completed successfully.

Windows

```
> cd sw/apps/windows
> syn1588.exe
```


The output of the syn1588 Utility on Windows will look like this example output:

```
syn1588(R) Driver Interface
Build date: Apr 19 2019 - V 1.8-4 Rev g274ca2e0
Copyright (c) Oregano Systems - Design & Consulting GesmbH 2005-2018
Confidential unpublished data - All rights reserved

Syn1588Ifc requires at least:
- linux driver version 1.4-15-g05b7283
- windows driver version 10/05/2017, 10.9.16.182
syn1588(R) Hardware Clock M 2.3.4 f=125000000 Hz
Selected syn1588(R) card 0
```

To start your PC as a PTP node, run the syn1588® PTP Stack as follows. Please change the IP-address or interface name accordingly to your system settings.

Starting the syn1588® PTP Stack

The syn1588® PTP Stack is a lightweight Precision Time Protocol stack which enables highly accurate clock synchronization in local area networks. For more information about the syn1588® PTP Stack please refer to the syn1588® User Guide  6.

Linux

```
> ptp -i eth4 -v2
```

Note


If you have several PTP nodes in your network, you can use a command line parameter to force the PTP mode of your nodes. Use the command line parameter „-CM_EXT“ to force a node into IEEE 1588 Master mode. Use the command line parameter „-CS“ to force your node into IEEE 1588 Slave mode.

Windows

```
> ptp.exe -i 10.0.0.2 -v2
```

FAQ, Caveats, and Common Traps and Pitfalls

- Linux kernels between 2.6.16 and 4.15 are supported.
- Windows Versions 7, 8, 8.1, 10, Server 2003, Server 2008 and Server 2012, 32 bit and 64 bit versions are supported.
- Please ensure, that your syn1588[®] PCIe NIC has an IP-address assigned. Check also for correct setting of the subnet mask, gateway IP address and DNS server.
- Check, if the IP-address set does not interfere with other IP-addresses on the same machine or in the network. Ideally a separated subnet should be assigned to all syn1588[®] PTP devices at least during initial testing.
- On all operating systems the syn1588[®] PTP Stack requires root-privileges to run correctly.
- Check, if the firewall blocks any PTP traffic. PTP (in layer 3 mode) communicates via IP/UDP port 319 and 320. Please make sure that these ports are not blocked by your firewall.
- Simple way to check the configured IP address and functioning of hardware and/or software is to ping another host IP address. Also Wireshark can be used to check if the packets are received/transmitted at the configured network interface.
- If there are difficulties in using the syn1588[®] hardware and/or software, generate a system information report as specified in the application note syn1588[®] System Information Report and send it to us for further support.

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