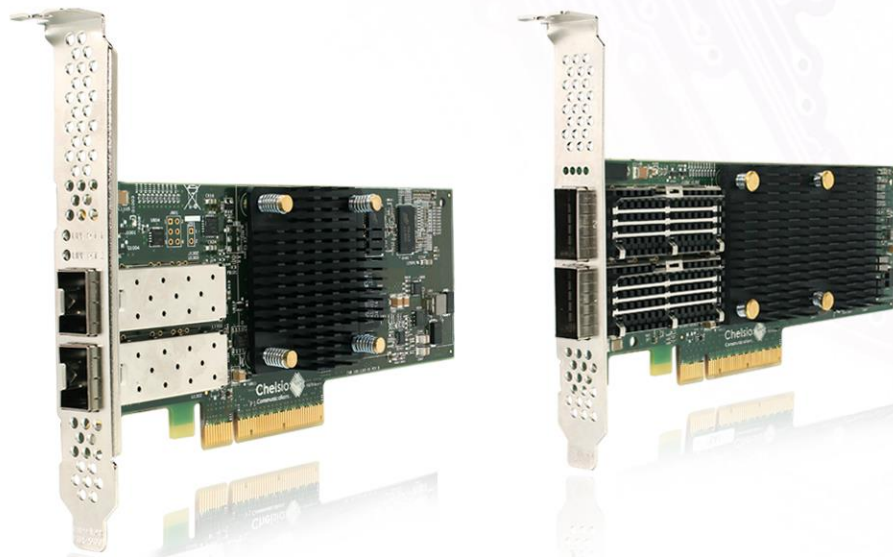




Chelsio Unified Wire for Linux

Installation and User's Guide



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1. Introduction

Thank you for choosing Chelsio Unified Wire adapters. These high speed, single chip, single firmware cards provide enterprises and data centers with high performance solutions for various Network and Storage related requirements.

The **Terminator** series is Chelsio's next generation of highly integrated, hyper-virtualized 1/10/25/40/50/100GbE controllers. The adapters are built around a programmable protocol-processing engine, with full offload of a complete Unified Wire solution comprising NIC, TOE, iWARP RDMA, iSCSI, FCoE and NAT support. It scales to true 100Gb line rate operation from a single TCP connection to thousands of connections, and allows simultaneous low latency and high bandwidth operation thanks to multiple physical channels through the ASIC.

Ideal for all data, storage and high performance clustering applications, the adapters enable a unified fabric over a single wire by simultaneously running all unmodified IP sockets, Fibre Channel and InfiniBand applications over Ethernet at line rate.

Designed for deployment in virtualized data centers, cloud service installations and high performance computing environments, Chelsio adapters bring a new level of performance metrics and functional capabilities to the computer networking industry.

NVIDIA's GPUDirect technology enables direct access to a Graphics Processing Unit (GPU) over the PCI bus, short-cutting the host system and allows for high bandwidth, high message rate and low latency communication. When coupled with iWARP RDMA technology, high performance direct access to GPU processing units can be expanded seamlessly to Ethernet and Internet scales.

This document describes the installation, use and maintenance of the GPUDirect RDMA driver and its various components.

1.1. Features

Chelsio Unified Wire installer is an easy to use utility developed for Chelsio adapters and installs the following components:

- Chelsio GPUDirect RDMA driver
- Tools (Open MPI, OSU Micro-benchmarks, PerfTest).

1.2. Hardware Requirements

1.2.1. Supported Adapters

The following are the currently shipping Chelsio adapters that are compatible with GPUDirect RDMA driver:

- T62100-CR
- T62100-LP-CR
- T6425-CR
- T6225-CR
- T6225-LL-CR

1.2.2. Adapter Requirements

- NVIDIA Tesla K series adapter should be installed in the machine (required by NVIDIA installer).
- Chelsio and NVIDIA adapters should be present in the same host CPU complex.

1.3. Software Requirements

The Chelsio GPUDirect RDMA Driver has been developed to run on 64-bit Linux based platforms. Following is the list of supported distributions:

- Kernel.org linux-4.14.67 (compiled on RHEL 7.5)

Other kernel versions have not been tested and are not guaranteed to work.

2. Hardware Installation

Follow these steps to install Chelsio adapter in your system:

- i. Shutdown/power off your system.
- ii. Power off all remaining peripherals attached to your system.
- iii. Unpack the Chelsio adapter and place it on an anti-static surface.
- iv. Remove the system case cover as per the system manufacturer's instructions.
- v. Remove the PCI filler plate from the slot where you will install the Ethernet adapter.
- vi. For maximum performance, it is highly recommended to install the adapter into a PCIe x8/x16 slot.

Note *All 4-ports of T6425-CR adapter will be functional only if PCIe x8 -> 2x PCIe x4 slot bifurcation is supported by the system and enabled in BIOS. Otherwise, only 2-ports will be functional.*

- vii. Holding the Chelsio adapter by the edges, align the edge connector with the PCI connector on the motherboard. Apply even pressure on both edges until the card is firmly seated. It may be necessary to remove the SFP (transceiver) modules prior to inserting the adapter.
- viii. Secure the Chelsio adapter with a screw, or other securing mechanism, as described by the system manufacturer's instructions. Replace the case cover.
- ix. After securing the card, ensure that the card is still fully seated in the PCIE x8/x16 slot as sometimes the process of securing the card causes the card to become unseated.
- x. Connect a fiber/twinax cable, multi-mode for short range (SR) optics or single-mode for long range (LR) optics, to the Ethernet adapter or regular Ethernet cable for the 1Gb Ethernet adapter.
- xi. Power on your system.
- xii. Run `update-pciids` command to download the current version of PCI ID list

```
[root@rhel7 ~]# update-pciids
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           %         %         Dload  Upload    Total   Spent    Left  Speed
100 227k 100 227k    0     0 68592      0  0:00:03  0:00:03 --:--:-- 68610
Done.
```

- xiii. Verify if the adapter was installed successfully by using the `lspci` command

```
[root@rhel7 ~]# lspci | grep -i Chelsio
81:00.0 Ethernet controller: Chelsio Communications Inc T62100-LP-CR Unified Wire Ethernet Controller
81:00.1 Ethernet controller: Chelsio Communications Inc T62100-LP-CR Unified Wire Ethernet Controller
81:00.2 Ethernet controller: Chelsio Communications Inc T62100-LP-CR Unified Wire Ethernet Controller
81:00.3 Ethernet controller: Chelsio Communications Inc T62100-LP-CR Unified Wire Ethernet Controller
81:00.4 Ethernet controller: Chelsio Communications Inc T62100-LP-CR Unified Wire Ethernet Controller
81:00.5 SCSI storage controller: Chelsio Communications Inc T62100-LP-CR Unified Wire Storage Controller
81:00.6 Fibre Channel: Chelsio Communications Inc T62100-LP-CR Unified Wire Storage Controller
```

For Chelsio adapters, the physical functions are currently assigned as:

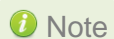
- Physical functions 0 - 3: for the SR-IOV functions of the adapter
- Physical function 4: for all NIC functions of the adapter
- Physical function 5: for iSCSI

- Physical function 6: for FCoE
- Physical function 7: Currently not assigned

Once Unified Wire package is installed and loaded, examine the output of `dmesg` to see if the card is discovered. You should see a similar output:

```
[ 1119.854346] cxgb4 0000:81:00.4: Chelsio T62100-LP-CR rev 0
[ 1119.854347] cxgb4 0000:81:00.4: S/N: RE41160042, P/N: 11012106003
[ 1119.854348] cxgb4 0000:81:00.4: Firmware version:
[ 1119.854349] cxgb4 0000:81:00.4: Bootstrap version: 255.255.255.255
[ 1119.854350] cxgb4 0000:81:00.4: TP Microcode version: 0.1.23.2
[ 1119.854351] cxgb4 0000:81:00.4: No Expansion ROM loaded
[ 1119.854351] cxgb4 0000:81:00.4: Serial Configuration version: 0x7002000
[ 1119.854352] cxgb4 0000:81:00.4: VPD version: 0x52
[ 1119.854354] cxgb4 0000:81:00.4: Configuration: NIC MSI-X, non-Offload capable
[ 1119.854355] eth0: Chelsio T62100-LP-CR (eth0) 100GBASE-CR4_QSFP
```

The above outputs indicate the hardware configuration of the adapter as well as serial number.



Note Network device names for Chelsio's physical ports are assigned using the following convention: the port farthest from the motherboard will appear as the first network interface. However, for T5 40G and T420-BT adapters, the association of physical Ethernet ports and their corresponding network device names is opposite. For these adapters, the port nearest to the motherboard will appear as the first network interface.

3. Software/Driver Installation

3.1. Pre-requisites

Please ensure that the following requirements are met before proceeding with the installation:

- Latest NVIDIA GPU driver should be installed. Download from <http://www.nvidia.com/Download/index.aspx?lang=en-us>
- CUDA 10 toolkit should be installed. Download from https://developer.nvidia.com/cuda-downloads?target_os=Linux&target_arch=x86_64&target_distro=RHEL&target_version=7&target_type=rpmnetwork
- Any Xorg process running in the system must be terminated:

```
[root@host~]# killall -9 /usr/bin/X
```

Use the following command to verify:

```
[root@host~]# ps -ef | grep -i /usr/bin/X
```

- Any previously loaded NVIDIA drivers must be unloaded.

```
[root@host~]# rmmod nvidia_uvm  
[root@host~]# rmmod nvidia
```

- Any previously installed Chelsio GPUDirect and Unified Wire driver packages must be uninstalled.

3.2. Installation

- i. Download the driver package from Chelsio Download Center, service.chelsio.com
- ii. Extract the package.

```
[root@host~]# tar zxvf ChelsioUwire-x.x.x.x.tar.gz
```

- iii. Change your working directory to Chelsio Unified Wire package directory.

```
[root@host~]# cd ChelsioUwire-x.x.x.x
```

- iv. Install 4.14.67 kernel from the package.

```
[root@host~]# make kernel_install
```

- v. Boot the machine into the newly installed kernel.
- vi. Install the GPUDirect RDMA drivers and tools.

```
[root@host~]# make gpudirect_install
```

- vii. Reboot your machine for changes to take effect.

4. Software/Driver Loading

Important Please ensure that all inbox drivers are unloaded before proceeding.

```
[root@host~]# rmmmod csiostor cxgb4i cxgbit iw_cxgb4 chcr cxgb4vf cxgb4  
libcxgbi libcxgb
```

The driver must be loaded by the root user. Any attempt to load as a regular user will fail.

- i. Load Chelsio iWARP (*iw_cxgb4*) and Transport Connection Manager (*rdma_ucm*) drivers:

```
[root@host~]# modprobe iw_cxgb4  
[root@host~]# modprobe rdma_ucm
```

- ii. Load the NVIDIA driver and GPU memory plug-in:

```
[root@host~]# modprobe nvidia  
[root@host~]# modprobe nv_peer_mem
```

5. Software/Driver Configuration and Fine Tuning

5.1. Checking iWARP connectivity

Use the Linux *ping* command to test basic connectivity via the Terminator interface. To test RDMA, use the *rping* command.

- i. Bring-up and assign IP to Chelsio interfaces.
- ii. Run server on one node.

```
[root@host~]# rping -s -a <local_ip> -p <listening_port> -C 1
```

- iii. Run client on other node.

```
[root@host~]# rping -c -a <server_ip> -p <listening_port> -C 1
```

Example:

Running Server

```
[root@server~]# rping -s -a 102.1.1.121 -C1 -vvvd -p 9999
port 9999
created cm_id 0x23895a0
rdma_bind_addr successful
rdma_listen
cma_event type RDMA_CM_EVENT_CONNECT_REQUEST cma_id 0x7fbb38000a30 (child)
child cma 0x7fbb38000a30
created pd 0x23889b0
created channel 0x23889d0
created cq 0x238c000
created qp 0x238d8d0
rping_setup_buffers called on cb 0x23862e0
allocated & registered buffers...
accepting client connection request
cq_thread started.
cma_event type RDMA_CM_EVENT_ESTABLISHED cma_id 0x7fbb38000a30 (child)
ESTABLISHED
rcv completion
Received rkey 91540 addr 21fa100 len 64 from peer
server received sink adv
server posted rdma read req
rdma read completion
server received read complete
server ping data: rdma-ping-0: ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz
server posted go ahead
send completion
rcv completion
Received rkey 9133f addr 21fa040 len 64 from peer
server received sink adv
rdma write from lkey 97943 laddr 238e1a0 len 64
rdma write completion
server rdma write complete
server posted go ahead
send completion
wait for RDMA_READ_ADV state 11
cma_event type RDMA_CM_EVENT_DISCONNECTED cma_id 0x7fbb38000a30 (child)
rping server failed: -1
server DISCONNECT EVENT...
rping_free_buffers called on cb 0x23862e0
destroy cm_id 0x23895a0
```

Running Client

```
[root@client~]# rping -c -a 102.1.1.121 -C1 -vvvd -p 9999
port 9999
created cm_id 0x21f5bb0
cma_event type RDMA_CM_EVENT_ADDR_RESOLVED cma_id 0x21f5bb0 (parent)
cma_event type RDMA_CM_EVENT_ROUTE_RESOLVED cma_id 0x21f5bb0 (parent)
rdma_resolve_addr - rdma_resolve_route successful
created pd 0x21f5e00
created channel 0x21f7f60
created cq 0x21f7f80
created qp 0x21f9850
rping_setup_buffers called on cb 0x21f2010
allocated & registered buffers...
cq_thread started.
cma_event type RDMA_CM_EVENT_ESTABLISHED cma_id 0x21f5bb0 (parent)
ESTABLISHED
rdma_connect successful
RDMA addr 21fa100 rkey 91540 len 64
send completion
recv completion
RDMA addr 21fa040 rkey 9133f len 64
send completion
recv completion
ping data: rdma-ping-0: ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqr
cma_event type RDMA_CM_EVENT_DISCONNECTED cma_id 0x21f5bb0 (parent)
client DISCONNECT EVENT...
rping_free_buffers called on cb 0x21f2010
destroy cm_id 0x21f5bb0
```

5.2. Running GPUDirect RDMA test

Following is an example of running a sample test using Open MPI. Before proceeding, please ensure that:

- Chelsio interfaces are able to ping/rping between the test nodes.
- Password less ssh is configured between the test nodes.

Run the following command:

```
[root@host~]# /usr/mpi/gcc/ompi-3.1.2-gdr/bin/mpirun --allow-run-as-root --
mca btl_openib_want_cuda_gdr 1 -np 2 --host <host1 ip>,<host2 ip> -npernode
1 --mca btl openib,vader,self --mca btl_openib_cuda_rdma_limit 4194432 --mca
btl_openib_receive_queues P,131072,64 -x CUDA_VISIBLE_DEVICES=0
/usr/mpi/gcc/ompi-3.1.2-gdr/tests/osu_bench/osu_bibw -d cuda D D
```

Example

```
[root@host ~]# /usr/mpi/gcc/ompi-3.1.2-gdr/bin/mpirun --allow-run-as-root --mca btl_op
enib_want_cuda_gdr 1 -np 2 --hostfile mpd.hosts --map-by node --mca btl openib,vader,s
elf --mca btl_openib_cuda_rdma_limit 4194432 --mca btl_openib_receive_queues P,131072
,64 -x CUDA_VISIBLE_DEVICES=0 /usr/mpi/gcc/ompi-3.1.2-gdr/tests/osu_bench/osu_bibw -d
cuda D D
# OSU MPI-CUDA Bi-Directional Bandwidth Test v5.0
# Send Buffer on DEVICE (D) and Receive Buffer on DEVICE (D)
# Size      Bandwidth (MB/s)
1           0.56
2           1.14
4           2.25
8           4.59
16          9.18
32          18.13
64          36.13
128         72.41
256         143.54
512         294.57
1024        565.21
2048        1069.02
4096        1682.62
8192        2104.40
16384       2449.70
32768       2769.47
65536       3070.91
131072      3214.82
262144      3161.66
524288      3420.15
1048576     3126.29
2097152     3175.69
4194304     3261.25
```

5.3. Firmware Update

The firmware is installed on the system, typically in `/lib/firmware/cxgb4`, and the driver will auto-load the firmware if an update is required. The kernel must be configured to enable userspace firmware loading support:

Device Drivers -> Generic Driver Options -> Userspace firmware loading support

The firmware version can be verified using `ethtool`:

```
[root@host~]# ethtool -i <iface>
```

6. Software/Driver Unloading

- i. Stop all GPUDirect RDMA traffic, servers and connections.
- ii. Unload NVIDIA GPU memory plug-in and NVIDIA driver:

```
[root@host~]# rmmod nv_peer_mem  
[root@host~]# rmmod nvidia_uvm  
[root@host~]# rmmod nvidia
```

- iii. Unload Chelsio iWARP driver(*iw_cxgb4*)

```
[root@host~]# rmmod iw_cxgb4
```

- iv. Unload Chelsio Network driver (*cxgb4*)

```
[root@host~]# rmmod cxgb4
```

- v. Finally, unload the Transport Connection Manager driver (*rdma_ucm*)

```
[root@host~]# rmmod rdma_ucm
```

7. Software/Driver Uninstallation

- i. Change your working directory to Chelsio Unified Wire package directory.

```
[root@host~]# cd ChelsioUwire-x.x.x.x
```

- ii. Uninstall GPUDirect RDMA drivers and tools using the below command.

```
[root@host~]# make gpudirect_uninstall
```

- iii. Reboot your machine for changes to take effect.

8. Software/Driver Update

For any distribution specific problems, please check README and Release Notes included in the release for possible workaround.

Please visit Chelsio support web site <http://service.chelsio.com/> for regular updates on various software/drivers. You can also subscribe to our newsletter for the latest software updates.

9. Appendix

9.1. Chelsio End-User License Agreement (EULA)

Installation and use of the driver/software implies acceptance of the terms in the Chelsio End-User License Agreement (EULA).

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