



# ConnectX<sup>®</sup>-4 VPI IC

## 100Gb/s InfiniBand & Ethernet Adapter IC

Single/Dual-Port Adapter supporting 10/25/40/50/56/100 Gb/s with Virtual Protocol Interconnect<sup>®</sup> and Mellanox Multi-Host Technology

ConnectX<sup>®</sup>-4 adapter with Virtual Protocol Interconnect (VPI), supporting 10/25/40/50/56/100 Gb/s InfiniBand and Ethernet connectivity, provides the highest performance and most flexible solution for high-performance, Web 2.0, Cloud, data analytics, database, and storage platforms.

With the exponential increase and usage of data, the advantages in scientific algorithms, and the creation of new applications, the demand for the highest interconnect throughput, lowest latency and sophisticated data acceleration engines continues to increase. ConnectX-4 enables data centers to leverage the world's leading interconnect adapter for increasing their applications while reducing operational and capital expenses.

ConnectX-4 provides an unmatched combination of 100Gb/s bandwidth, sub-700ns latency and 150 million messages per second. It includes native hardware support for RDMA over InfiniBand and Ethernet, Ethernet stateless offload engines, GPUDirect<sup>®</sup>, and the Mellanox Multi-Host<sup>®</sup> technology.

Mellanox Multi-Host technology enables the next generation scalable data center design to achieve maximum CAPEX and OPEX savings without compromising on network performance.

### HPC Environments

ConnectX-4 delivers high bandwidth, low latency, and high computation efficiency for the High Performance Computing clusters. Collective operation is a communication pattern in HPC in which all members of a group of processes participate and share data.

CORE-Direct<sup>®</sup> (Collective Offload Resource Engine) provides advanced capabilities for implementing MPI and SHMEM collective operations. It enhances collective communication scalability and minimizes the CPU overhead for such operations, while providing asynchronous and high-performance collective communication capabilities. It also enhances application scalability by reducing the exposure of the collective communication to the effects of system noise (the bad effect of system activity on running jobs). ConnectX-4 enhances the CORE-Direct capabilities by removing the restriction on the data length for which data reductions are supported.

### Mellanox Multi-Host Technology

Mellanox Multi-Host<sup>®</sup> technology enables connecting multiple hosts into a single interconnect adapter by separating the ConnectX-4 PCIe interface into multiple and independent interfaces. Each interface can be connected to a separate host with no performance degradation. ConnectX-4 offers four fully-independent PCIe buses, lowering total cost of ownership in the data center by reducing CAPEX requirements from four cables, NICs, and switch ports to only one of each, and by reducing OPEX by cutting down on switch port management and overall power usage.

Each host can be active or inactive at any time, independent of the other hosts, and receives bandwidth of its own. Bandwidth is split between the hosts, either evenly (default) or based on configurable differentiated Quality of Service (QoS), depending on the data center's needs.

## HIGHLIGHTS

### BENEFITS

- 10/25/40/50/56/100 Gb/s connectivity for servers and storage
- Industry-leading throughput and low latency performance for HPC, web access and storage
- Maximizing data center return on investment (ROI) with Mellanox Multi-Host technology
- Smart interconnect for x86, Power, ARM, and GPU-based compute and storage platforms
- Cutting-edge performance in virtualized overlay networks (NVGRE)
- Efficient I/O consolidation, lowering data center costs and complexity
- Virtualization acceleration
- Power efficiency

### FEATURES

- EDR 100Gb/s InfiniBand or 100Gb/s Ethernet per port
- Single and dual-port options available
- 10/25/40/50/56/100 Gb/s speeds
- 150M messages/second
- Mellanox Multi-Host technology
- Connectivity to up to 4 independent hosts
- Hardware offloads for NVGRE and VXLAN encapsulated traffic
- CPU offloading of transport operations
- Application offloading
- Mellanox PeerDirect communication acceleration
- End-to-end QoS and congestion control
- Hardware-based I/O virtualization
- T10-DIF Signature Handover
- Ethernet encapsulation (EoIB)
- Typical power of 1-port EDR/100GbE – 11.2W (ATIS score)
- RoHS compliant

Mellanox Multi-Host technology features uncompromising independent host management, with full independent NC-SI/MCTP support to each host and to the NIC. IT managers can remotely control the configuration and power state of each host individually, such that management of one host does not affect host traffic performance or the management of the other hosts, guaranteeing host security and isolation. To further lower the total cost of ownership, ConnectX-4 supports management of the multiple hosts using a single BMC, with independent NC-SI/MCTP management channels for each of the managed hosts.

Mellanox Multi-Host also supports a heterogeneous data center architecture; the various hosts connected to the single adapter can be x86, Power, GPU, or Arm, thereby removing any limitations in passing data or communicating between CPUs.

## I/O Virtualization

ConnectX-4 SR-IOV technology provides dedicated adapter resources and guaranteed isolation and protection for virtual machines (VMs) within the server. I/O virtualization with ConnectX-4 gives data center administrators better server utilization while reducing cost, power, and cable complexity, allowing more Virtual Machines and more tenants on the same hardware. ConnectX-4's SR-IOV capability and Mellanox Multi-Host technology are mutually exclusive, and each host in a multi-host server can leverage an individual SR-IOV implementation.

## Overlay Networks

In order to better scale Ethernet networks, data center operators often create overlay networks that carry traffic from individual virtual machines over logical tunnels in encapsulated formats such as NVGRE. While this solves network scalability issues, it hides the TCP packet from the hardware offloading engines, placing higher loads on the host CPU. ConnectX-4 effectively addresses this by providing advanced NVGRE hardware offloading engines that encapsulate and de-encapsulate the overlay protocol headers, and enable the traditional offloads to be performed on the encapsulated traffic for these and other tunneling protocols (GENEVE, MPLS, QinQ, and so on). With ConnectX-4, data center operators can achieve native performance in the new network architecture.

## RDMA

ConnectX-4 VPI utilizes both IBTA RDMA (Remote Direct Memory Access) and RoCE (RDMA over Converged Ethernet) technologies, delivering low-latency and high performance. ConnectX-4 leverages data center bridging (DCB) capabilities and advanced congestion control hardware mechanisms to provide efficient low-latency RDMA services over Layer 2 and Layer 3 networks.

## Mellanox PeerDirect

Mellanox PeerDirect® communication provides high efficiency RDMA access by eliminating unnecessary internal data copies between components on the PCIe bus (for example, from GPU to CPU), and therefore significantly reduces application run time. ConnectX-4 advanced acceleration technology enables higher cluster efficiency and scalability to tens of thousands of nodes.

## Storage Acceleration

Storage applications will see improved performance with the higher bandwidth EDR delivers. Moreover, standard block and file access protocols can leverage RoCE for high-performance storage access. A consolidated compute and storage network achieves significant cost-performance advantages over multi-fabric networks.

## Signature Handover

ConnectX-4 supports hardware checking of T10 Data Integrity Field / Protection Information (T10-DIF/PI), reducing the CPU overhead and accelerating delivery of data to the application. Signature handover is handled by the adapter on ingress and/or egress packets, reducing the load on the CPU at the Initiator and/or Target machines.

## Standard & Multi-Host Management

Mellanox's host management technology for standard and multi-host platforms optimizes board management and power, performance and firmware update management via NC-SI, MCTP over SMBus and MCTP over PCIe, as well as PLDM for Monitor and Control DSP0248 and PLDM for Firmware Update DSP0267.

## Software Support

All Mellanox adapter cards are supported by Windows, Linux distributions, VMware, FreeBSD, and Citrix XENServer. ConnectX-4 support various management interfaces and has a rich set of tool for configuration and management across operating systems.

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## Compatibility

### PCI Express Interface

- PCIe Gen 3.0 compliant, 2.0 and 1.1 compatible
- 2.5, 5.0, or 8.0 GT/s link rate x16
- Auto-negotiates to x16, x8, x4, x2, or x1
- Support for MSI/MSI-X mechanisms

### Operating Systems/Distributions\*

- RHEL/CentOS
- Windows
- FreeBSD
- VMware
- OpenFabrics Enterprise Distribution (OFED)
- OpenFabrics Windows Distribution (WinOF)

### Connectivity

- Interoperable with 10/25/40/50/56/100 Gb/s Ethernet switches
- Passive copper cable with ESD protection
- Powered connectors for optical and active cable support

## Features\*

### InfiniBand

- EDR / FDR / QDR / DDR / SDR
- IBTA Specification 1.3 compliant
- RDMA, Send/Receive semantics
- Hardware-based congestion control
- Atomic operations
- 16 million I/O channels
- 256 to 4Kbyte MTU, 2Gbyte messages
- 8 virtual lanes + VL15

### Ethernet

- 100GbE / 56GbE / 50GbE / 40GbE / 25GbE / 10GbE
- IEEE 802.3bj, 802.3bm 100 Gigabit Ethernet
- 25G Ethernet Consortium 25, 50 Gigabit Ethernet
- IEEE 802.3ba 40 Gigabit Ethernet
- IEEE 802.3ae 10 Gigabit Ethernet
- IEEE 802.3az Energy Efficient Ethernet
- IEEE 802.3ap based auto-negotiation and KR startup
- Proprietary Ethernet protocols (20/40GBASE-R2, 50/56GBASE-R4); may be available on specific SKUs
- IEEE 802.3ad, 802.1AX Link Aggregation
- IEEE 802.1Q, 802.1P VLAN tags and priority
- IEEE 802.1Qau (QCN) – Congestion Notification
- IEEE 802.1Qaz (ETS)
- IEEE 802.1Qbb (PFC)
- IEEE 802.1Qbg
- IEEE 1588v2
- Jumbo frame support (9.6KB)

### Enhanced Features

- Hardware-based reliable transport
- Collective operations offloads
- Vector collective operations offloads
- Mellanox PeerDirect RDMA (aka GPUDirect®) communication acceleration
- 64/66 encoding
- Extended Reliable Connected transport (XRC)
- Dynamically Connected transport (DCT)
- Enhanced Atomic operations
- Advanced memory mapping support, allowing user mode registration and remapping of memory (UMR)
- On demand paging (ODP)
- Registration free RDMA memory access

### Mellanox Multi-Host

- Up to 4 separate PCIe interfaces to 4 independent hosts
- Two PCIe x8 to two hosts or four PCIe x4 to four hosts
- Independent NC-SI SMBus interfaces
- Independent stand-by and wake-on-LAN signals

### Storage Offloads

- T10 DIF - Signature handover operation at wire speed, for ingress and egress traffic

### Overlay Networks

- Stateless offloads for overlay networks and tunneling protocols
- Hardware offload of encapsulation and decapsulation of NVGRE overlay networks

### Hardware-Based I/O Virtualization

- Single Root IOV
- Multi-function per port
- Address translation and protection
- Multiple queues per virtual machine
- Enhanced QoS for vNICs
- VMware NetQueue supports

### Virtualization

- SR-IOV: Up to 256 Virtual Functions
- SR-IOV: Up to 16 Physical Functions per port
- Virtualization hierarchies (e.g., NPAR and Mellanox Multi-Host)
  - Virtualizing Physical Functions on a physical port
  - SR-IOV on every Physical Function
- 1K ingress and egress QoS levels
- Guaranteed QoS for VMs

### CPU Offloads

- RDMA over Converged Ethernet (RoCE)
- TCP/UDP/IP stateless offload
- LSO, LRO, checksum offload
- RSS (can be done on encapsulated packet), TSS, HDS, VLAN insertion / stripping, Receive flow steering
- Intelligent interrupt coalescence

### Remote Boot

- Remote boot over InfiniBand
- Remote boot over Ethernet
- Remote boot over iSCSI
- PXE and UEFI

### Protocol Support

- OpenMPI, IBM PE, OSU MPI (MVAPICH/2), Intel MPI
- Platform MPI, UPC, Open SHMEM
- TCP/UDP, MPLS, VxLAN, NVGRE, GENEVE
- SRP, iSER, NFS RDMA, SMB Direct
- uDAPL

### Management and Control Interfaces

- NC-SI, MCTP over SMBus and MCTP over PCIe - Baseboard Management Controller interface
- PLDM for Monitor and Control DSP0248
- PLDM for Firmware Update DSP0267
- SDN management interface for managing the eSwitch
- I<sup>2</sup>C interface for device control and configuration
- General Purpose I/O pins
- SPI interface to flash
- JTAG IEEE 1149.1 and IEEE 1149.6

\* This section describes hardware features and capabilities. Please refer to the driver and firmware release notes for feature availability.

Table 1 - Part Numbers and Descriptions

OPN	Description
MT27704A0-FDCF-FV	ConnectX-4 VPI, 1-port IC, FDR/56GbE, PCIe 3.0 x16, 8GT/s
MT27708A0-FDCF-FV	ConnectX-4 VPI, 2-port IC, FDR/56GbE, PCIe 3.0 x16, 8GT/s
MT27704A0-FDCF-EV	ConnectX-4 VPI, 1-port IC, EDR/100GbE, PCIe 3.0 x16, 8GT/s
MT27708A0-FDCF-EV	ConnectX-4 VPI, 2-port IC, EDR/100GbE, PCIe 3.0 x16, 8GT/s
MT27708A0-FDCF-FVM	ConnectX-4 VPI, 2-port IC, FDR/56GbE, Mellanox Multi-Host, PCIe 3.0 x16, 8GT/s
MT27708A0-FDCF-EVM	ConnectX-4 VPI, 2-port IC, EDR/100GbE, Mellanox Multi-Host, PCIe 3.0 x16, 8GT/s



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