High-Performance Ethernet Adapter Card Product Line

Intelligent Network Adapters with Advanced Hardware Offloads and Unequaled RoCE Capabilities, Enabling Data Center Efficiency and Scalability
Mellanox® Ethernet Network Interface Cards (NICs) enable the highest data center performance for hyperscale, public and private clouds, storage, machine learning, artificial intelligence, big data and telco platforms

World-Class Performance and Scale
Mellanox 10, 25, 40, 50, 100, and 200 Gigabit Ethernet NICs deliver industry-leading connectivity for performance-driven server and storage applications. These ConnectX adapter cards enable high bandwidth coupled with ultra-low latency for diverse applications and systems, resulting in faster access and real-time responses.

ConnectX adapter cards provide best-in-class performance and efficient computing through advanced acceleration and offload capabilities, including RDMA over Converged Ethernet (RoCE), NVMe-over-Fabrics (NVMe-oF), virtual switch offloads, GPU communication acceleration, hardware acceleration for virtualization, and the connectivity of multiple compute or storage hosts to a single interconnect adapter. ConnectX network acceleration technology frees the CPU resources for compute tasks, allowing for higher scalability and efficiency within.

Complete End-to-End Ethernet Networking
ConnectX adapter cards are part of Mellanox’s 10, 25, 40, 50, 100 and 200GbE end-to-end portfolio for data centers which also includes Open Ethernet switches, application acceleration packages, and cabling to deliver a unique price-performance value proposition for network and storage solutions. Using Mellanox, IT managers can be assured of the highest performance, reliability and most efficient network fabric at the lowest cost for the best return on investment.

In addition, for certain flavors of ConnectX cards, Mellanox NEO-Host management software greatly simplify host network provisioning, monitoring and diagnostics, providing the agility and efficiency for scalability and future growth. Featuring an intuitive and graphical user interface (GUI), NEO-Host provides in-depth visibility and host networking control. NEO-Host also integrates with Mellanox NEO, Mellanox’s end-to-end data-center orchestration and management platform.
I/O Virtualization and Virtual Switching

Mellanox adapters provide comprehensive support for virtualized data centers with Single-Root I/O Virtualization (SR-IOV) allowing dedicated adapter resources and guaranteed isolation and protection for virtual machines within the server. I/O virtualization gives data center managers better server utilization and LAN and SAN unification while reducing cost, power and cable complexity. In addition, VirtIO hardware emulation has been added to ConnectX-6.

Moreover, virtual machines running in a server are traditionally using hypervisor’s switch capabilities, like Open vSwitch (OVS). Mellanox ASAP® Accelerated Switching And Packet Processing® Direct technology allows offloading any implementation of a virtual switch or virtual router by handling the data plane in the NIC hardware while maintaining the control plane unmodified. As a result, significantly higher vSwitch/vRouter performance can be achieved without the associated CPU load.

RDMA over Converged Ethernet (RoCE)

Mellanox adapter cards offer RoCE to provide efficient data transfer with very low latencies on Ethernet networks — a key factor in maximizing a cluster’s ability to process data instantaneously. With the increasing use of fast and distributed storage, data centers have reached the point of yet another disruptive change, making RoCE a must in today’s data centers. In ConnectX-5 and above, RoCE can operate in lossy fabrics without the need to configure PFC or ECN.

Flexible Multi-Host® Technology

Mellanox’s innovative Multi-Host technology provides high flexibility and major savings in building next generation, scalable, high-performance data centers. Multi-Host connects multiple compute or storage hosts to a single interconnect adapter, separating the adapter PCIe interface into multiple and independent PCIe interfaces with no performance degradation. The technology enables designing and building new scale-out heterogeneous compute and storage racks with direct connectivity among compute elements, storage elements and the network. This enables better power and performance management, while achieving maximum data processing and data transfer at minimum capital and operational expenses.
Accelerated Storage

A consolidated compute and storage network achieves significant cost-performance advantages over multi-fabric networks. Standard block and file access protocols leverage RDMA to achieve high-performance storage access. Mellanox adapters support a rich variety of storage protocols and enable partners to build hyperconverged platforms where the compute and storage nodes are co-located and share the same infrastructure. Leveraging RDMA, Mellanox adapters enhance numerous storage protocols, such as iSCSI over RDMA (iSER), NFS RDMA, and SMB Direct. Moreover, ConnectX adapters also offer NVMe-oF protocols and offloads, enhancing the utilization of NVMe based storage appliances.

Other storage related hardware offloads include the Signature Handover mechanism based on the advanced T-10/DIF implementation, and the Erasure Coding offloading capability enabling the building of a distributed RAID (Redundant Array of Inexpensive Disks).

Enhancing Machine Learning Application Performance

Mellanox Ethernet adapters with built-in advanced acceleration and RDMA capabilities deliver best-in-class latency, bandwidth and message rates, coupled with low CPU utilization. Mellanox PeerDirect™ technology with NVIDIA GPUDirect™ RDMA enables adapters with direct peer-to-peer communication to GPU memory with no interruption to CPU operations. Mellanox adapters also deliver the highest scalability, efficiency, and performance for a variety of applications, including bioscience, media and entertainment, automotive design, computational fluid dynamics and manufacturing, weather research and forecasting, as well as oil and gas industry modeling. Thus, Mellanox adapters are the best NICs for machine learning applications.

Host Management

Mellanox host management sideband implementations enable remote monitor and control capabilities using RBT, MCTP over SMBus, and MCTP over PCIe – Baseboard Management Controller (BMC) interface, which supports both NC-SI and PLDM management protocols using these interfaces. Mellanox adapters support these protocols to offer numerous Host Management features including PLDM for Firmware Update, network boot in UEFI driver, UEFI secure boot, and more.

Various Form Factors

Mellanox offers a variety of adapters in different form factors to meet the specific needs of any data center. In addition to standard PCIe adapter cards, Mellanox provides:

- Open Compute Project (OCP) cards that integrate into the most cost-efficient, energy-efficient and scalable enterprise and hyperscale data centers, delivering leading connectivity for performance-driven server and storage applications. The OCP mezzanine adapter form factor is designed to mate into OCP servers. ConnectX OCP adapter cards are available supporting OCP Specifications 0.5, 2.0 and 3.0.
- A unique form-factor network adapter consisting of two PCIe cards, whose PCIe lanes are split between two slots. This configuration maximizes PCIe bandwidth beyond a server’s single PCIe slot limit, such as when connecting x32 lanes of PCIe gen 3.0 to achieve 200GbE. This configuration is also very useful in dual socket servers that utilize Mellanox Socket Direct® technology.

Broad Software Support

All Mellanox adapter cards are supported by a full suite of drivers for Linux major distributions, Microsoft® Windows®, VMware vSphere® and FreeBSD®. Drivers are also available inbox in Linux main distributions, Windows and VMware.
ConnectX®-6 Adapter Cards*

ConnectX-6 is a groundbreaking addition to the Mellanox ConnectX series of industry-leading adapter cards. Delivering two ports of up to 200GbE connectivity, sub-800ns latency and industry-leading 215 million messages per second, ConnectX-6 adapter cards provide the highest performance and most flexible interconnect solution for demanding data center applications. With ConnectX-6, Mellanox offers several new features and performance improvements over previous versions, including data-at-rest storage encryption, advanced host-chaining (enabling building small switch-less clusters), VirtIO hardware emulation, and Hardware Root of Trust for secure boot to round out server security.

ConnectX-6 network adapters are available for PCIe Gen3 and Gen4 servers, and provide support for 10, 25, 40, 50, 100, and 200GbE speeds in standup PCIe card (single or dual-slot) and OCP 3.0 form factors, as well as Mellanox Multi-Host® and Socket Direct® offerings.

ConnectX®-5 and ConnectX®-5-Ex Adapter Cards

ConnectX-5 and ConnectX-5 Ex adapter cards provide high performance and flexible solutions, with up to two ports of 100GbE connectivity, 750ns latency, and up to 200 million messages per second. For storage workloads, ConnectX-5 brings a range of innovative accelerations, such as Erasure Coding for RAID offloads, Signature Handover (T10-DIF) in hardware, an embedded PCIe Switch and NVMe over Fabric Targets offloads.

In addition, ConnectX-5 is capable of reaching a record-setting message rate of 150 million packets per second (Mpps) running an open source Data Path Development Kit (DPDK). The ConnectX-5 network adapters also bring advanced OVS Offloads to telecommunication and cloud data centers. ConnectX-5 network adapters are available for PCIe Gen3 and Gen4 servers (ConnectX-5 Ex) and provide support for 25, 40, 50 and 100GbE speeds in standup PCIe card, OCP 2.0, 3.0 and OEM customized form factors. ConnectX-5 adapter cards also offer advanced Mellanox Multi-Host and Socket Direct.

ConnectX®-4 Lx Adapter Cards

ConnectX-4 Lx adapter cards are the perfect flexible, agile and high performance NIC for cloud applications, supporting 10/25/40/50GbE connectivity and providing an unmatched combination of bandwidth with sub-microsecond latency and a high message rate. ConnectX-4 LX also includes native hardware support for RDMA over Converged Ethernet (RoCE), Ethernet stateless offloads, and hardware support for Overlay networks. ConnectX-4 Lx network adapters are available for PCIe Gen3 servers and provide support for 10, 25, 40 and 50GbE speeds in standard standup PCIe, OCP 2.0 / 3.0 and OEM customized form factors. In addition, advanced Mellanox Multi-Host technology is offered with ConnectX-4 Lx OCP cards.

ConnectX®-4 Adapter Cards

ConnectX-4 network adapter cards support up to 100GbE connectivity, providing a high performance and a flexible solution for machine learning, data analytics, database, and storage platforms. ConnectX-4 network adapters are available for PCIe servers and provide support for 10, 40, 50 and 100GbE speeds in standard standup PCIe and OEM customized form factors. For new designs Mellanox recommends using the newer and more advanced ConnectX-5 or ConnectX-6.

ConnectX®-3 Pro Adapter Cards

ConnectX-3 Pro adapters provide high-performance, flexible 10/40GbE interconnect solutions (and up to 56GbE when connected to a Mellanox switch). ConnectX-3 Pro first introduced Stateless offloads for Overlay Network tunneling technologies such as VXLAN and NVGRE, in addition to native hardware support for RDMA over Converged Ethernet (RoCE), Ethernet stateless offloads.

ConnectX-3 Pro network adapters are available for PCIe Gen3 servers and provide support for 10, 40 and 56GbE speeds in standard standup PCIe, OCP 2.0 and OEM customized form factors.

*Contact Mellanox for availability
## General Specs

<table>
<thead>
<tr>
<th></th>
<th>ConnectX™ 3* Pro</th>
<th>ConnectX™ 4*</th>
<th>ConnectX™ 4Lx</th>
<th>ConnectX™ 5</th>
<th>ConnectX™ 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ports</strong></td>
<td>Single, Dual</td>
<td>Single, Dual</td>
<td>Single, Dual</td>
<td>Single, Dual</td>
<td>Single, Dual</td>
</tr>
<tr>
<td><strong>Port Speed (Gb/s)</strong></td>
<td>10, 40, 56**</td>
<td>10, 25, 40, 50, 56**, 100</td>
<td>10, 25, 40, 50</td>
<td>10, 25, 40, 50, 100</td>
<td>10, 25, 40, 50, 100, 200</td>
</tr>
<tr>
<td><strong>PCIe</strong></td>
<td>Gen3 x8</td>
<td>Gen3 x8, Gen3 x16</td>
<td>Gen3 x8</td>
<td>Gen3 x16, Gen4 x16</td>
<td>2x Gen3 x16, Gen4 x16</td>
</tr>
<tr>
<td><strong>Connectors</strong></td>
<td>QSFP+</td>
<td>QSFP28</td>
<td>QSFP28, SFP28</td>
<td>QSFP28, SFP28</td>
<td>QSFP56, SFP-DD</td>
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<tr>
<td><strong>Message Rate (DPDK)</strong></td>
<td>28</td>
<td>92</td>
<td>75</td>
<td>200 (ConnectX-5 Ex, Gen4 server)</td>
<td>148 (ConnectX-5 Ex, Gen3)</td>
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<tr>
<td><strong>RoCE Latency at Max Speed</strong></td>
<td>0.67</td>
<td>0.79</td>
<td>0.83</td>
<td>0.75</td>
<td>215</td>
</tr>
<tr>
<td><strong>Typical Power (2 ports, max speed)</strong></td>
<td>6.2W</td>
<td>16.3W</td>
<td>7.4W</td>
<td>19.3W (ConnectX-5 Ex, Gen4 server)</td>
<td>16.2W (ConnectX-5, Gen3 server)</td>
</tr>
</tbody>
</table>

### RDMA over Converged Ethernet (RoCE)
- ConnectX™ 3* Pro: ✓ (no PCN/PFC)
- ConnectX™ 4*: ✓ (no PCN/PFC)
- ConnectX™ 4Lx: ✓ (no PCN/PFC)
- ConnectX™ 5: ✓ (no PCN/PFC)
- ConnectX™ 6: ✓ (no PCN/PFC)

### OOO RDMA (Adaptive Routing)
- ConnectX™ 3* Pro: –
- ConnectX™ 4*: –
- ConnectX™ 4Lx: –
- ConnectX™ 5: ✓
- ConnectX™ 6: ✓

### Dynamically Connected Transport
- ConnectX™ 3* Pro: –
- ConnectX™ 4*: ✓
- ConnectX™ 4Lx: ✓
- ConnectX™ 5: ✓
- ConnectX™ 6: ✓

### Flexible Pipeline Programmability (enhancing future protocols)
- ConnectX™ 3* Pro: –
- ConnectX™ 4*: –
- ConnectX™ 4Lx: –
- ConnectX™ 5: ✓
- ConnectX™ 6: ✓

### Packet Pacing
- ConnectX™ 3* Pro: –
- ConnectX™ 4*: ✓
- ConnectX™ 4Lx: –
- ConnectX™ 5: ✓
- ConnectX™ 6: ✓

### Host Chaining
- ConnectX™ 3* Pro: –
- ConnectX™ 4*: –
- ConnectX™ 4Lx: –
- ConnectX™ 5: ✓ (using hairpin)
- ConnectX™ 6: ✓

### Embedded PCIe Switch
- ConnectX™ 3* Pro: –
- ConnectX™ 4*: ✓
- ConnectX™ 4Lx: ✓
- ConnectX™ 5: ✓
- ConnectX™ 6: ✓

### NVMe-oF Target Offload
- ConnectX™ 3* Pro: –
- ConnectX™ 4*: –
- ConnectX™ 4Lx: –
- ConnectX™ 5: ✓
- ConnectX™ 6: ✓

### Erasure Coding (RAID Offload)
- ConnectX™ 3* Pro: –
- ConnectX™ 4*: –
- ConnectX™ 4Lx: ✓
- ConnectX™ 5: ✓
- ConnectX™ 6: ✓

### T-10 Diff/Signature Handover
- ConnectX™ 3* Pro: –
- ConnectX™ 4*: ✓
- ConnectX™ 4Lx: –
- ConnectX™ 5: ✓
- ConnectX™ 6: ✓

### Burst Buffer Offloads
- ConnectX™ 3* Pro: –
- ConnectX™ 4*: –
- ConnectX™ 4Lx: –
- ConnectX™ 5: ✓
- ConnectX™ 6: ✓
<table>
<thead>
<tr>
<th>Security</th>
<th>ConnectX-3*</th>
<th>ConnectX-4*</th>
<th>ConnectX-4 Lx</th>
<th>ConnectX-5</th>
<th>ConnectX-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block-level Encryption/Decryption (AES-XTS)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>✓</td>
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<tr>
<td>Secure Firmware Update</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Secure Boot (HW RoT)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>✓</td>
</tr>
<tr>
<td>Stateful Rule Checking</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>✓</td>
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</table>

<table>
<thead>
<tr>
<th>Virtualization &amp; Cloud</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>SR-IOV</td>
<td>127 VFs</td>
<td>16 Pfs per port, 256 VFs</td>
<td>16 Pfs per port, 256 VFs</td>
<td>16 Pfs per port, 1K VFs per port</td>
<td>16 Pfs per port, 1K VFs per port</td>
</tr>
<tr>
<td>Multi-Host</td>
<td>–</td>
<td>4 hosts</td>
<td>4 hosts</td>
<td>4 hosts</td>
<td>8 hosts</td>
</tr>
<tr>
<td>Congestion Control (ECN)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>MPI Tag Matching Offload</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>✓</td>
</tr>
<tr>
<td>OVS Offload</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Enhanced vSwitch Offloads</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>VirtIO Hardware Emulation</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>✓</td>
</tr>
</tbody>
</table>

| Overlay Networks               |              |              |              |            |            |
| RoCE over Overlay Networks     | –           | –           | –             |            | ✓          |
| Stateless Offloads for Overlay Network Tunneling Protocols | ✓           | ✓           | ✓             | ✓          | ✓          |
| Hardware Offload of Encapsulation and Decapsulation of VXLAN, NVGRE, and GENEVE Overlay Networks | –           | –           | ✓             | ✓          | ✓          |

| Available Form Factors         |              |              |              |            |            |
| Standard PCIe                  | ✓           | ✓           | ✓             | ✓          | ✓          |
| OCP                            | Spec 2.0    | –           | Spec 2.0/3.0  | Spec 2.0/3.0 | Spec 3.0 |
| Socket Direct                  | –           | –           | –             | –          | ✓          |

**NOTE**: Please refer to specific product and software/firmware release notes for feature availability.

* ConnectX-4 Lx, ConnectX-6 EN and ConnectX-6 EN offer richer feature sets that are recommended for the latest market applications.

** 56GbE is supported when connected to a Mellanox switch.
For detailed information on features, compliance, and compatibility, please see each product’s specific product brief.