

[ NCCL ](../index.html)

[2.25](https://docs.nvidia.com/deeplearning/sdk/nccl-archived/index.html)

- \* [Overview of NCCL](../overview.html)

- \* [Setup](../setup.html)

- \* [Using NCCL](../usage.html)

- \* [Creating a Communicator](communicators.html)

- \* [Creating a communicator with options](communicators.html#creating-a-communicator-with-options)

- \* [Creating a communicator using multiple ncclUniqueIds](communicators.html#creating-a-communicator-using-multiple-nccluniqueids)

- \* [Creating more communicators](communicators.html#creating-more-communicators)

- \* [Using multiple NCCL communicators concurrently](communicators.html#using-multiple-nccl-communicators-concurrently)

- \* [Finalizing a communicator](communicators.html#finalizing-a-communicator)

- \* [Destroying a communicator](communicators.html#destroying-a-communicator)

- \* [Error handling and communicator abort](communicators.html#error-handling-and-communicator-abort)

- \* [Asynchronous errors and error handling](communicators.html#asynchronous-errors-and-error-handling)

- \* [Fault Tolerance](communicators.html#fault-tolerance)

- \* Collective Operations

- \* AllReduce

- \* Broadcast

- \* Reduce

- \* AllGather

- \* [ReduceScatter](#)
- \* [\[Data Pointers\]\(data.html\)](#)
- \* [\[CUDA Stream Semantics\]\(streams.html\)](#)
  - \* [\[Mixing Multiple Streams within the same ncclGroupStart/End\(\) group\]\(streams.html#mixing-multiple-streams-within-the-same-ncclgroupstart-end-group\)](#)
- \* [\[Group Calls\]\(groups.html\)](#)
  - \* [\[Management Of Multiple GPUs From One Thread\]\(groups.html#management-of-multiple-gpus-from-one-thread\)](#)
  - \* [\[Aggregated Operations \(2.2 and later\)\]\(groups.html#aggregated-operations-2-2-and-later\)](#)
  - \* [\[Nonblocking Group Operation\]\(groups.html#nonblocking-group-operation\)](#)
- \* [\[Point-to-point communication\]\(p2p.html\)](#)
  - \* [\[Sendrecv\]\(p2p.html#sendrecv\)](#)
  - \* [\[One-to-all \(scatter\)\]\(p2p.html#one-to-all-scatter\)](#)
  - \* [\[All-to-one \(gather\)\]\(p2p.html#all-to-one-gather\)](#)
  - \* [\[All-to-all\]\(p2p.html#all-to-all\)](#)
  - \* [\[Neighbor exchange\]\(p2p.html#neighbor-exchange\)](#)
- \* [\[Thread Safety\]\(threadsafety.html\)](#)
- \* [\[In-place Operations\]\(inplace.html\)](#)
- \* [\[Using NCCL with CUDA Graphs\]\(cudagraph.html\)](#)
- \* [\[User Buffer Registration\]\(bufferreg.html\)](#)
  - \* [\[NVLink Sharp Buffer Registration\]\(bufferreg.html#nvlink-sharp-buffer-registration\)](#)
  - \* [\[IB Sharp Buffer Registration\]\(bufferreg.html#ib-sharp-buffer-registration\)](#)
  - \* [\[General Buffer Registration\]\(bufferreg.html#general-buffer-registration\)](#)
  - \* [\[Memory Allocator\]\(bufferreg.html#memory-allocator\)](#)
- \* [\[NCCL API\]\(../api.html\)](#)
  - \* [\[Communicator Creation and Management Functions\]\(../api/comms.html\)](#)
  - \* [\[ncclGetLastError\]\(../api/comms.html#ncclgetlasterror\)](#)

- \* [\[ncclGetErrorString\]\(../api/comms.html#ncclgeterrorstring\)](#)
- \* [\[ncclGetVersion\]\(../api/comms.html#ncclgetversion\)](#)
- \* [\[ncclGetUniqueId\]\(../api/comms.html#ncclgetuniqueid\)](#)
- \* [\[ncclCommInitRank\]\(../api/comms.html#ncclcomminitrank\)](#)
- \* [\[ncclCommInitAll\]\(../api/comms.html#ncclcomminitall\)](#)
- \* [\[ncclCommInitRankConfig\]\(../api/comms.html#ncclcomminitrankconfig\)](#)
- \* [\[ncclCommInitRankScalable\]\(../api/comms.html#ncclcomminitrankscalable\)](#)
- \* [\[ncclCommSplit\]\(../api/comms.html#ncclcommsplit\)](#)
- \* [\[ncclCommFinalize\]\(../api/comms.html#ncclcommfinalize\)](#)
- \* [\[ncclCommDestroy\]\(../api/comms.html#ncclcommdestroy\)](#)
- \* [\[ncclCommAbort\]\(../api/comms.html#ncclcommabort\)](#)
- \* [\[ncclCommGetAsyncError\]\(../api/comms.html#ncclcommgetasyncerror\)](#)
- \* [\[ncclCommCount\]\(../api/comms.html#ncclcommcount\)](#)
- \* [\[ncclCommCuDevice\]\(../api/comms.html#ncclcommcudevice\)](#)
- \* [\[ncclCommUserRank\]\(../api/comms.html#ncclcommuserrank\)](#)
- \* [\[ncclCommRegister\]\(../api/comms.html#ncclcommregister\)](#)
- \* [\[ncclCommDeregister\]\(../api/comms.html#ncclcommderegister\)](#)
- \* [\[ncclMemAlloc\]\(../api/comms.html#ncclmemalloc\)](#)
- \* [\[ncclMemFree\]\(../api/comms.html#ncclmemfree\)](#)
- \* [\[Collective Communication Functions\]\(../api/colls.html\)](#)
  - \* [\[ncclAllReduce\]\(../api/colls.html#ncclallreduce\)](#)
  - \* [\[ncclBroadcast\]\(../api/colls.html#ncclbroadcast\)](#)
  - \* [\[ncclReduce\]\(../api/colls.html#ncclreduce\)](#)
  - \* [\[ncclAllGather\]\(../api/colls.html#ncclallgather\)](#)
  - \* [\[ncclReduceScatter\]\(../api/colls.html#ncclreducescatter\)](#)
- \* [\[Group Calls\]\(../api/group.html\)](#)
  - \* [\[ncclGroupStart\]\(../api/group.html#ncclgroupstart\)](#)

- \* [\[ncclGroupEnd\]\(../api/group.html#ncclgroupend\)](#)
- \* [\[ncclGroupSimulateEnd\]\(../api/group.html#ncclgroupsimulateend\)](#)
- \* [\[Point To Point Communication Functions\]\(../api/p2p.html\)](#)
- \* [\[ncclSend\]\(../api/p2p.html#ncclsend\)](#)
- \* [\[ncclRecv\]\(../api/p2p.html#ncclrecv\)](#)
- \* [\[Types\]\(../api/types.html\)](#)
- \* [\[ncclComm\\_t\]\(../api/types.html#ncclcomm-t\)](#)
- \* [\[ncclResult\\_t\]\(../api/types.html#ncclresult-t\)](#)
- \* [\[ncclDataType\\_t\]\(../api/types.html#nccldatatype-t\)](#)
- \* [\[ncclRedOp\\_t\]\(../api/types.html#ncclredop-t\)](#)
- \* [\[ncclScalarResidence\\_t\]\(../api/types.html#ncclscalarresidence-t\)](#)
- \* [\[ncclConfig\\_t\]\(../api/types.html#ncclconfig-t\)](#)
- \* [\[ncclSimInfo\\_t\]\(../api/types.html#ncclsiminfo-t\)](#)
- \* [\[User Defined Reduction Operators\]\(../api/ops.html\)](#)
- \* [\[ncclRedOpCreatePreMulSum\]\(../api/ops.html#ncclredopcreatepremulsum\)](#)
- \* [\[ncclRedOpDestroy\]\(../api/ops.html#ncclredopdestroy\)](#)
- \* [\[Migrating from NCCL 1 to NCCL 2\]\(../nccl1.html\)](#)
- \* [\[Initialization\]\(../nccl1.html#initialization\)](#)
- \* [\[Communication\]\(../nccl1.html#communication\)](#)
- \* [\[Counts\]\(../nccl1.html#counts\)](#)
- \* [\[In-place usage for AllGather and ReduceScatter\]\(../nccl1.html#in-place-usage-for-allgather-and-reducescatter\)](#)
- \* [\[AllGather arguments order\]\(../nccl1.html#allgather-arguments-order\)](#)
- \* [\[Datatypes\]\(../nccl1.html#datatypes\)](#)
- \* [\[Error codes\]\(../nccl1.html#error-codes\)](#)
- \* [\[Examples\]\(../examples.html\)](#)
- \* [\[Communicator Creation and Destruction\]](#)

Examples](../examples.html#communicator-creation-and-destruction-examples)

- \* [Example 1: Single Process, Single Thread, Multiple Devices](../examples.html#example-1-single-process-single-thread-multiple-devices)

- \* [Example 2: One Device per Process or Thread](../examples.html#example-2-one-device-per-process-or-thread)

- \* [Example 3: Multiple Devices per Thread](../examples.html#example-3-multiple-devices-per-thread)

- \* [Example 4: Multiple communicators per device](../examples.html#example-4-multiple-communicators-per-device)

- \* [Communication Examples](../examples.html#communication-examples)

- \* [Example 1: One Device per Process or Thread](../examples.html#example-1-one-device-per-process-or-thread)

- \* [Example 2: Multiple Devices per Thread](../examples.html#example-2-multiple-devices-per-thread)

- \* [NCCL and MPI](../mpi.html)

- \* [API](../mpi.html#api)

- \* [Using multiple devices per process](../mpi.html#using-multiple-devices-per-process)

- \* [ReduceScatter operation](../mpi.html#reducescatter-operation)

- \* [Send and Receive counts](../mpi.html#send-and-receive-counts)

- \* [Other collectives and point-to-point operations](../mpi.html#other-collectives-and-point-to-point-operations)

- \* [In-place operations](../mpi.html#in-place-operations)

- \* [Using NCCL within an MPI Program](../mpi.html#using-nccl-within-an-mpi-program)

- \* [MPI Progress](../mpi.html#mpi-progress)

- \* [Inter-GPU Communication with CUDA-aware MPI](../mpi.html#inter-gpu-communication-with-cuda-aware-mpi)

- \* [Environment Variables](../env.html)

\* [System configuration](../env.html#system-configuration)

\* [NCCL\_SOCKET\_IFNAME](../env.html#nccl-socket-ifname)

\* [Values accepted](../env.html#values-accepted)

\* [NCCL\_SOCKET\_FAMILY](../env.html#nccl-socket-family)

\* [Values accepted](../env.html#id2)

\* [NCCL\_SOCKET\_RETRY\_CNT](../env.html#nccl-socket-retry-cnt)

\* [Values accepted](../env.html#id3)

\* [NCCL\_SOCKET\_RETRY\_SLEEP\_MSEC](../env.html#nccl-socket-retry-sleep-msec)

\* [Values accepted](../env.html#id4)

\* [NCCL\_SOCKET\_NTHREADS](../env.html#nccl-socket-nthreads)

\* [Values accepted](../env.html#id5)

\* [NCCL\_NSOCKS\_PERTHREAD](../env.html#nccl-nsocks-perthread)

\* [Values accepted](../env.html#id6)

\* [NCCL\_CROSS\_NIC](../env.html#nccl-cross-nic)

\* [Values accepted](../env.html#id7)

\* [NCCL\_IB\_HCA](../env.html#nccl-ib-hca)

\* [Values accepted](../env.html#id8)

\* [NCCL\_IB\_TIMEOUT](../env.html#nccl-ib-timeout)

\* [Values accepted](../env.html#id9)

\* [NCCL\_IB\_RETRY\_CNT](../env.html#nccl-ib-retry-cnt)

\* [Values accepted](../env.html#id10)

\* [NCCL\_IB\_GID\_INDEX](../env.html#nccl-ib-gid-index)

\* [Values accepted](../env.html#id11)

\* [NCCL\_IB\_ADDR\_FAMILY](../env.html#nccl-ib-addr-family)

\* [Values accepted](../env.html#id12)

\* [NCCL\_IB\_ADDR\_RANGE](../env.html#nccl-ib-addr-range)

\* [Values accepted](../env.html#id13)

\* [NCCL\_IB\_ROCE\_VERSION\_NUM](../env.html#nccl-ib-roce-version-num)  
\* [Values accepted](../env.html#id14)

\* [NCCL\_IB\_SL](../env.html#nccl-ib-sl)  
\* [Values accepted](../env.html#id15)

\* [NCCL\_IB\_TC](../env.html#nccl-ib-tc)  
\* [Values accepted](../env.html#id16)

\* [NCCL\_IB\_FIFO\_TC](../env.html#nccl-ib-fifo-tc)  
\* [Values accepted](../env.html#id17)

\* [NCCL\_IB\_RETURN\_ASYNC\_EVENTS](../env.html#nccl-ib-return-async-events)  
\* [Values accepted](../env.html#id18)

\* [NCCL\_OOB\_NET\_ENABLE](../env.html#nccl-oob-net-enable)  
\* [Values accepted](../env.html#id19)

\* [NCCL\_OOB\_NET\_IFNAME](../env.html#nccl-oob-net-ifname)  
\* [Values accepted](../env.html#id20)

\* [NCCL\_UID\_STAGGER\_THRESHOLD](../env.html#nccl-uid-stagger-threshold)  
\* [Values accepted](../env.html#id21)

\* [NCCL\_UID\_STAGGER\_RATE](../env.html#nccl-uid-stagger-rate)  
\* [Values accepted](../env.html#id22)

\* [NCCL\_NET](../env.html#nccl-net)  
\* [Values accepted](../env.html#id23)

\* [NCCL\_NET\_PLUGIN](../env.html#nccl-net-plugin)  
\* [Values accepted](../env.html#id24)

\* [NCCL\_TUNER\_PLUGIN](../env.html#nccl-tuner-plugin)  
\* [Values accepted](../env.html#id25)

\* [NCCL\_PROFILER\_PLUGIN](../env.html#nccl-profiler-plugin)  
\* [Values accepted](../env.html#id26)

\* [NCCL\_IGNORE\_CPU\_AFFINITY](../env.html#nccl-ignore-cpu-affinity)

- \* [Values accepted](../env.html#id27)
- \* [NCCL\_CONF\_FILE](../env.html#nccl-conf-file)
- \* [Values accepted](../env.html#id28)
- \* [NCCL\_DEBUG](../env.html#nccl-debug)
- \* [Values accepted](../env.html#id30)
- \* [NCCL\_DEBUG\_FILE](../env.html#nccl-debug-file)
- \* [Values accepted](../env.html#id31)
- \* [NCCL\_DEBUG\_SUBSYS](../env.html#nccl-debug-subsys)
- \* [Values accepted](../env.html#id32)
- \* [NCCL\_COLLNET\_ENABLE](../env.html#nccl-collnet-enable)
- \* [Value accepted](../env.html#value-accepted)
- \* [NCCL\_COLLNET\_NODE\_THRESHOLD](../env.html#nccl-collnet-node-threshold)
- \* [Value accepted](../env.html#id33)
- \* [NCCL\_TOPO\_FILE](../env.html#nccl-topo-file)
- \* [Value accepted](../env.html#id34)
- \* [NCCL\_TOPO\_DUMP\_FILE](../env.html#nccl-topo-dump-file)
- \* [Value accepted](../env.html#id35)
- \* [NCCL\_SET\_THREAD\_NAME](../env.html#nccl-set-thread-name)
- \* [Value accepted](../env.html#id36)
- \* [Debugging](../env.html#debugging)
- \* [NCCL\_P2P\_DISABLE](../env.html#nccl-p2p-disable)
- \* [Values accepted](../env.html#id37)
- \* [NCCL\_P2P\_LEVEL](../env.html#nccl-p2p-level)
- \* [Values accepted](../env.html#id38)
- \* [Integer Values (Legacy)](../env.html#integer-values-legacy)
- \* [NCCL\_P2P\_DIRECT\_DISABLE](../env.html#nccl-p2p-direct-disable)
- \* [Values accepted](../env.html#id39)



\* [NCCL\_SHM\_DISABLE](../env.html#nccl-shm-disable)  
\* [Values accepted](../env.html#id40)

\* [NCCL\_BUFFSIZE](../env.html#nccl-buffersize)  
\* [Values accepted](../env.html#id41)

\* [NCCL\_NTHREADS](../env.html#nccl-nthreads)  
\* [Values accepted](../env.html#id42)

\* [NCCL\_MAX\_NCHANNELS](../env.html#nccl-max-nchannels)  
\* [Values accepted](../env.html#id43)

\* [NCCL\_MIN\_NCHANNELS](../env.html#nccl-min-nchannels)  
\* [Values accepted](../env.html#id44)

\* [NCCL\_CHECKS\_DISABLE](../env.html#nccl-checks-disable)  
\* [Values accepted](../env.html#id45)

\* [NCCL\_CHECK\_POINTERS](../env.html#nccl-check-pointers)  
\* [Values accepted](../env.html#id46)

\* [NCCL\_LAUNCH\_MODE](../env.html#nccl-launch-mode)  
\* [Values accepted](../env.html#id47)

\* [NCCL\_IB\_DISABLE](../env.html#nccl-ib-disable)  
\* [Values accepted](../env.html#id48)

\* [NCCL\_IB\_AR\_THRESHOLD](../env.html#nccl-ib-ar-threshold)  
\* [Values accepted](../env.html#id49)

\* [NCCL\_IB\_QPS\_PER\_CONNECTION](../env.html#nccl-ib-qps-per-connection)  
\* [Values accepted](../env.html#id50)

\* [NCCL\_IB\_SPLIT\_DATA\_ON\_QPS](../env.html#nccl-ib-split-data-on-qps)  
\* [Values accepted](../env.html#id51)

\* [NCCL\_IB\_CUDA\_SUPPORT](../env.html#nccl-ib-cuda-support)  
\* [Values accepted](../env.html#id52)

\* [NCCL\_IB\_PCI\_RELAXED\_ORDERING](../env.html#nccl-ib-pci-relaxed-ordering)

\* [Values accepted](../env.html#id53)

\* [NCCL\_IB\_ADAPTIVE\_ROUTING](../env.html#nccl-ib-adaptive-routing)

\* [Values accepted](../env.html#id54)

\* [NCCL\_IB\_ECE\_ENABLE](../env.html#nccl-ib-ece-enable)

\* [Values accepted](../env.html#id55)

\* [NCCL\_MEM\_SYNC\_DOMAIN](../env.html#nccl-mem-sync-domain)

\* [Values accepted](../env.html#id56)

\* [NCCL\_CUMEM\_ENABLE](../env.html#nccl-cumem-enable)

\* [Values accepted](../env.html#id57)

\* [NCCL\_CUMEM\_HOST\_ENABLE](../env.html#nccl-cumem-host-enable)

\* [Values accepted](../env.html#id58)

\* [NCCL\_NET\_GDR\_LEVEL (formerly

NCCL\_IB\_GDR\_LEVEL)](../env.html#nccl-net-gdr-level-formerly-nccl-ib-gdr-level)

\* [Values accepted](../env.html#id59)

\* [Integer Values (Legacy)](../env.html#id60)

\* [NCCL\_NET\_GDR\_READ](../env.html#nccl-net-gdr-read)

\* [Values accepted](../env.html#id61)

\* [NCCL\_NET\_SHARED\_BUFFERS](../env.html#nccl-net-shared-buffers)

\* [Value accepted](../env.html#id62)

\* [NCCL\_NET\_SHARED\_COMMS](../env.html#nccl-net-shared-comms)

\* [Value accepted](../env.html#id63)

\* [NCCL\_SINGLE\_RING\_THRESHOLD](../env.html#nccl-single-ring-threshold)

\* [Values accepted](../env.html#id64)

\* [NCCL\_LL\_THRESHOLD](../env.html#nccl-ll-threshold)

\* [Values accepted](../env.html#id65)

\* [NCCL\_TREE\_THRESHOLD](../env.html#nccl-tree-threshold)

\* [Values accepted](../env.html#id66)

\* [NCCL\_ALGO](../env.html#nccl-algo)

\* [Values accepted](../env.html#id67)

\* [NCCL\_PROTO](../env.html#nccl-proto)

\* [Values accepted](../env.html#id68)

\* [NCCL\_NVX\_DISABLE](../env.html#nccl-nvx-disable)

\* [Value accepted](../env.html#id69)

\* [NCCL\_P2P\_DISABLE](../env.html#nccl-p2p-disable)

\* [Value accepted](../env.html#id70)

\* [NCCL\_P2P\_P2P\_LEVEL](../env.html#nccl-p2p-p2p-level)

\* [Value accepted](../env.html#id71)

\* [NCCL\_RUNTIME\_CONNECT](../env.html#nccl-runtime-connect)

\* [Value accepted](../env.html#id72)

\* [NCCL\_GRAPH\_REGISTER](../env.html#nccl-graph-register)

\* [Value accepted](../env.html#id74)

\* [NCCL\_LOCAL\_REGISTER](../env.html#nccl-local-register)

\* [Value accepted](../env.html#id75)

\* [NCCL\_LEGACY\_CUDA\_REGISTER](../env.html#nccl-legacy-cuda-register)

\* [Value accepted](../env.html#id76)

\* [NCCL\_SET\_STACK\_SIZE](../env.html#nccl-set-stack-size)

\* [Value accepted](../env.html#id77)

\* [NCCL\_GRAPH\_MIXING\_SUPPORT](../env.html#nccl-graph-mixing-support)

\* [Value accepted](../env.html#id79)

\* [NCCL\_DMABUF\_ENABLE](../env.html#nccl-dmabuf-enable)

\* [Value accepted](../env.html#id80)

\* [NCCL\_P2P\_NET\_CHUNKSIZE](../env.html#nccl-p2p-net-chunksize)

\* [Values accepted](../env.html#id81)

\* [NCCL\_P2P\_LL\_THRESHOLD](../env.html#nccl-p2p-ll-threshold)

- \* [\[Values accepted\]\(../env.html#id82\)](#)
- \* [\[NCCL\\_ALLOC\\_P2P\\_NET\\_LL\\_BUFFERS\]\(../env.html#nccl-alloc-p2p-net-ll-buffers\)](#)
- \* [\[Values accepted\]\(../env.html#id83\)](#)
- \* [\[NCCL\\_COMM\\_BLOCKING\]\(../env.html#nccl-comm-blocking\)](#)
- \* [\[Values accepted\]\(../env.html#id84\)](#)
- \* [\[NCCL\\_CGA\\_CLUSTER\\_SIZE\]\(../env.html#nccl-cga-cluster-size\)](#)
- \* [\[Values accepted\]\(../env.html#id85\)](#)
- \* [\[NCCL\\_MAX\\_CTAS\]\(../env.html#nccl-max-ctas\)](#)
- \* [\[Values accepted\]\(../env.html#id86\)](#)
- \* [\[NCCL\\_MIN\\_CTAS\]\(../env.html#nccl-min-ctas\)](#)
- \* [\[Values accepted\]\(../env.html#id87\)](#)
- \* [\[NCCL\\_NVLS\\_ENABLE\]\(../env.html#nccl-nvls-enable\)](#)
- \* [\[Values accepted\]\(../env.html#id88\)](#)
- \* [\[NCCL\\_IB\\_MERGE\\_NICS\]\(../env.html#nccl-ib-merge-nics\)](#)
- \* [\[Values accepted\]\(../env.html#id89\)](#)
- \* [\[NCCL\\_MNNVL\\_ENABLE\]\(../env.html#nccl-mnnvl-enable\)](#)
- \* [\[Values accepted\]\(../env.html#id90\)](#)
- \* [\[NCCL\\_RAS\\_ENABLE\]\(../env.html#nccl-ras-enable\)](#)
- \* [\[Values accepted\]\(../env.html#id91\)](#)
- \* [\[NCCL\\_RAS\\_ADDR\]\(../env.html#nccl-ras-addr\)](#)
- \* [\[Values accepted\]\(../env.html#id92\)](#)
- \* [\[NCCL\\_RAS\\_TIMEOUT\\_FACTOR\]\(../env.html#nccl-ras-timeout-factor\)](#)
- \* [\[Values accepted\]\(../env.html#id93\)](#)
- \* [\[Troubleshooting\]\(../troubleshooting.html\)](#)
- \* [\[Errors\]\(../troubleshooting.html#errors\)](#)
- \* [\[RAS\]\(../troubleshooting.html#ras\)](#)
- \* [\[RAS\]\(../troubleshooting/ras.html\)](#)

- \* [\[Principle of Operation\]\(../troubleshooting/ras.html#principle-of-operation\)](#)
- \* [\[RAS Queries\]\(../troubleshooting/ras.html#ras-queries\)](#)
- \* [\[Sample Output\]\(../troubleshooting/ras.html#sample-output\)](#)
- \* [\[GPU Direct\]\(../troubleshooting.html#gpu-direct\)](#)
- \* [\[GPU-to-GPU communication\]\(../troubleshooting.html#gpu-to-gpu-communication\)](#)
- \* [\[GPU-to-NIC communication\]\(../troubleshooting.html#gpu-to-nic-communication\)](#)
- \* [\[PCI Access Control Services \(ACS\)\]\(../troubleshooting.html#pci-access-control-services-ac\)](#)
- \* [\[Topology detection\]\(../troubleshooting.html#topology-detection\)](#)
- \* [\[Shared memory\]\(../troubleshooting.html#shared-memory\)](#)
- \* [\[Docker\]\(../troubleshooting.html#docker\)](#)
- \* [\[Systemd\]\(../troubleshooting.html#systemd\)](#)
- \* [\[Networking issues\]\(../troubleshooting.html#networking-issues\)](#)
- \* [\[IP Network Interfaces\]\(../troubleshooting.html#ip-network-interfaces\)](#)
- \* [\[IP Ports\]\(../troubleshooting.html#ip-ports\)](#)
- \* [\[InfiniBand\]\(../troubleshooting.html#infiniband\)](#)
- \* [\[RDMA over Converged Ethernet \(RoCE\)\]\(../troubleshooting.html#rdma-over-converged-ethernet-roce\)](#)

[\\_\\_\[NCCL\]\(../index.html\)](#)

- \* [\[Docs\]\(../index.html\)](#) »
- \* [\[Using NCCL\]\(../usage.html\)](#) »
- \* [Collective Operations](#)
- \* [\[ View page source\]\(../\\_sources/usage/collectives.rst.txt\)](#)

\* \* \*

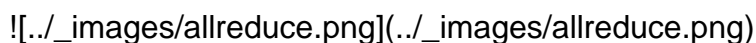
## # Collective Operations¶

Collective operations have to be called for each rank (hence CUDA device), using the same count and the same datatype, to form a complete collective operation. Failure to do so will result in undefined behavior, including hangs, crashes, or data corruption.

## ## AllReduce¶

The AllReduce operation performs reductions on data (for example, sum, min, max) across devices and stores the result in the receive buffer of every rank.

In a `_sum_` allreduce operation between `_k_` ranks, each rank will provide an array in of N values, and receive identical results in array out of N values, where  $out[i] = in_0[i] + in_1[i] + \dots + in_{(k-1)}[i]$ .

The diagram shows a sequence of ranks (0 to k-1) each providing an input array of N values. These inputs are reduced (summed) across all ranks, and the resulting array of N values is then broadcast to every rank, so each rank receives the same output.

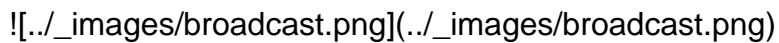
All-Reduce operation: each rank receives the reduction of input values across ranks.

Related links: [`ncclAllReduce()`](../api/colls.html#c.ncclAllReduce "ncclAllReduce").

## ## Broadcast¶

The Broadcast operation copies an N-element buffer from the root rank to all

the ranks.

![\_images/broadcast.png](../\_images/broadcast.png)

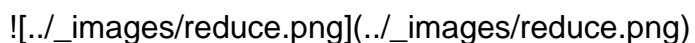
Broadcast operation: all ranks receive data from a "root" rank.

Important note: The root argument is one of the ranks, not a device number, and is therefore impacted by a different rank to device mapping.

Related links: [ncclBroadcast()](../api/colls.html#c.ncclBroadcast "ncclBroadcast").

## ## Reduce¶

The Reduce operation performs the same operation as AllReduce, but stores the result only in the receive buffer of a specified root rank.

![\_images/reduce.png](../\_images/reduce.png)

Reduce operation: one rank receives the reduction of input values across ranks.

Important note: The root argument is one of the ranks (not a device number), and is therefore impacted by a different rank to device mapping.

Note: A Reduce, followed by a Broadcast, is equivalent to the AllReduce operation.

Related links: [`ncclReduce()`](../api/colls.html#c.ncclReduce "ncclReduce").

## ## AllGather¶

The AllGather operation gathers  $N$  values from  $k$  ranks into an output buffer of size  $k*N$ , and distributes that result to all ranks.

The output is ordered by the rank index. The AllGather operation is therefore impacted by a different rank to device mapping.

![\_images/allgather.png](../\_images/allgather.png)

AllGather operation: each rank receives the aggregation of data from all ranks in the order of the ranks.

Note: Executing ReduceScatter, followed by AllGather, is equivalent to the AllReduce operation.

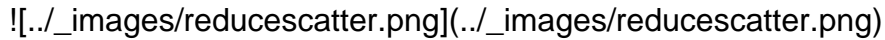
Related links: [`ncclAllGather()`](../api/colls.html#c.ncclAllGather "ncclAllGather").

## ## ReduceScatter¶

The ReduceScatter operation performs the same operation as Reduce, except that the result is scattered in equal-sized blocks between ranks, each rank getting a chunk of data based on its rank index.



The ReduceScatter operation is impacted by a different rank to device mapping since the ranks determine the data layout.



Reduce-Scatter operation: input values are reduced across ranks, with each rank receiving a subpart of the result.

Related links: [`ncclReduceScatter()`](../api/colls.html#c.ncclReduceScatter "ncclReduceScatter")

[Next](data.html "Data Pointers") [Previous](communicators.html "Creating a Communicator")

\* \* \*

(C) Copyright 2020, NVIDIA Corporation

Built with [Sphinx](http://sphinx-doc.org/) using a [theme](https://github.com/rtfd/sphinx\_rtd\_theme) provided by [Read the Docs](https://readthedocs.org).