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NCCL Algorithms and Protocols: Selection and Debugging

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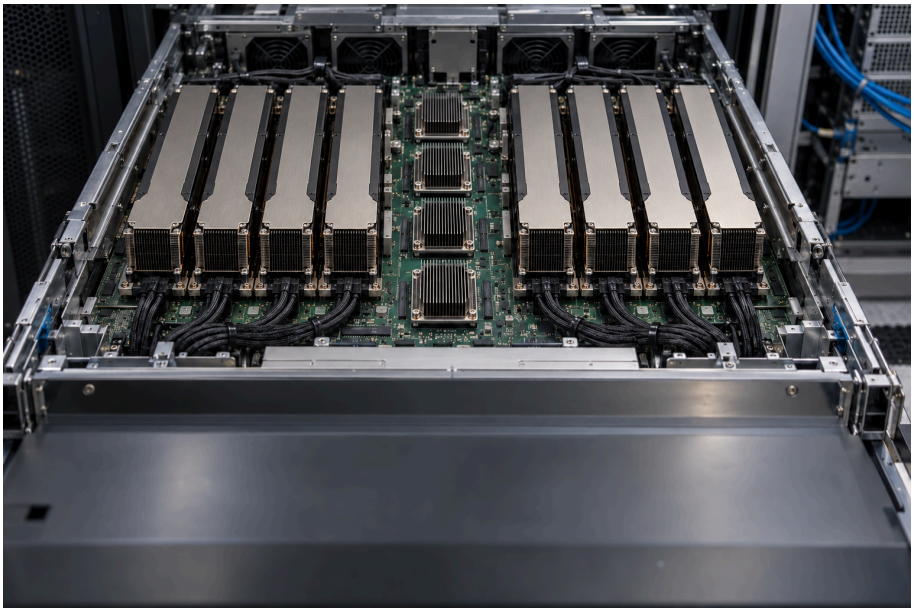

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Executive Summary

NVIDIA Collective Communication Library (NCCL) algorithms and protocols describe different decisions. An algorithm organizes a collective's communication and reduction work; a protocol governs how that work moves and synchronizes data. **Ring** and **Tree** are algorithm families. **Simple**, **low latency (LL)**, and **LL128** are protocols. The research presentation treats these separately from transport, so a network-provider log cannot by itself establish the selected algorithm. (spcl.ethz.ch) (docs.aws.amazon.com)

Automatic selection should remain the baseline. PyTorch documents NCCL tuning based on detected topology. This report recommends an override only when it tests a named hypothesis under a frozen configuration, with correctness checks and a defined rollback. That recommendation also follows NVIDIA's instruction to remove debugging settings after resolving the issue. (docs.pytorch.org) (docs.nvidia.com) This report recommends application confirmation for any isolated collective gain.

The current reference is **NCCL 2.32.3**, as identified by the opened NVIDIA release notes on **October 13, 2026**. (docs.nvidia.com) The report pins **nccl-tests 2.21.1** to commit **afd59abab774a6a4b492eb344bd0c845a0b7bb4d**, whose version-bump commit is dated **October 5, 2026**. (github.com) Its **-U 1** option reports tuning information with NCCL **2.28 or newer**; symmetric-collective identification and kernel-variant reporting require **2.31 or newer**. (raw.githubusercontent.com) Current NCCL INFO-level **TUNING** logs also expose operation-level choices. (docs.nvidia.com) Preserve these records alongside topology and transport evidence rather than inferring selection from a constructed Ring alone.

Three interpretation boundaries matter. First, the latest displayed revision of **Demystifying NCCL** is dated **March 2, 2026**, but its implementation analysis concerns **NCCL 2.19.1**. (arxiv.org) (arxiv.org) Second, nccl-tests **algbw** and **busbw** are different calculated quantities; the AllReduce correction is **2(n-1)/n**, not a direct measurement of traffic on every physical link. (raw.githubusercontent.com) Third, **NVLS (NVLink SHARP)** is hardware-qualified. (docs.nvidia.com) **SHARP** expands to **Scalable Hierarchical Aggregation and Reduction Protocol**. (networking-docs.nvidia.com) Verify availability and initialization against the installed

version. The practical decision is whether a measured difference survives matched operation semantics, byte counts, placement, correctness, and application execution. A temporary override can answer that question; a faster synthetic result alone cannot justify fabric replacement or a permanent setting.

Introduction and Background

Distributed training and inference operators encounter several questions inside a slow collective: whether ranks requested the same operation, whether the intended network provider loaded, whether placement changed, and whether the selected execution path suits the workload. A useful investigation separates those questions before comparing bandwidth numbers. The Message Passing Interface (MPI) standard explicitly distinguishes collective semantics from an illustrative communication arrangement: a pictured gathering focus is not a mandated implementation. (www.mpi-forum.org)

This report examines **NCCL Ring vs Tree**, **LL vs LL128 vs Simple**, and the documented NVLS and CollNet paths as an operational selection map. It covers algorithm and protocol selection, NCCL_ALGO and NCCL_PROTO experiments, NCCL_DEBUG evidence, and AllReduce performance interpretation. It supplies no universal best values. Open MPI's separate collective library likewise documents that algorithms perform differently in different situations; its controls are useful comparative context, not NCCL configuration instructions. (docs.open-mpi.org)

The academic reference has a clear provenance. ETH Zurich lists **Demystifying NCCL** in the proceedings of the **2025 Symposium on High-Performance Interconnects (HOTI)**. (spcl.ethz.ch) Its revised publication date and the NCCL version studied must be recorded independently. (arxiv.org) Historical diagrams and protocol explanations can aid understanding while current documentation determines today's supported controls.

GPU Smith's first-party method describes work against written acceptance criteria. (gpusmith.com) That adjacent engineering perspective motivates an evidence package: identify the configuration, preserve the experiment, and make the resulting decision reviewable. The existing **GPU Cluster Acceptance Testing: DCGM and NCCL Runbook** addresses contractual topology, workload, statistics, and thresholds. (gpusmith.com) This report confines its decision to selection and debugging. Contractual acceptance floors and general fabric procurement require their own evidence.

Readers should treat the recommendations below as an analytical procedure. A reported selection is an observation about a particular run. An override is a hypothesis about that observation. A deployment recommendation requires evidence that extends beyond the diagnostic process.

Separate the Collective, Algorithm, Protocol, and Transport

Collective semantics specify the result and participants. AllReduce leaves a reduced result at every rank; Reduce leaves it at the designated root. NCCL documents ReduceScatter followed by AllGather as semantically equivalent to AllReduce. That equivalence does not require every implementation to execute those two calls. (docs.nvidia.com) Matching count and datatype across participating ranks is a correctness requirement, not a performance preference. (docs.nvidia.com)

Algorithm topology describes the arrangement of the work. A logical Ring or Tree need not reproduce physical switch cabling. The MPI standard's distinction between diagrams and semantics is particularly useful here: a schematic explains an arrangement without establishing the implementation selected for a run. (www.mpi-forum.org) **Protocol** is another dimension: the NCCL research presentation lists Simple, LL, and LL128 separately from transport and algorithm choices. (spcl.ethz.ch)

Use this glossary as the crosswalk between test inputs and evidence:

- **Collective:** Record the operation and its required result before comparing implementations. The MPI standard separates semantics from illustrative arrangements. (www.mpi-forum.org)
- **Rank:** A participating endpoint. In nccl-tests, total ranks equal processes multiplied by threads per process multiplied by graphics processing units (GPUs) per thread. (raw.githubusercontent.com)
- **Algorithm:** Record the selected communication organization separately from the provider.
- **Protocol:** The data-transfer and synchronization scheme used within that execution path. Historical NVIDIA material describes LL as transferring self-flagged data. (www.olcf.ornl.gov)
- **Transport/provider:** The underlying communication mechanism. AWS's **Elastic Fabric Adapter (EFA)** verification instructions identify the selected network provider in NCCL logs. (docs.aws.amazon.com)
- **Channels and execution resources:** Record parallel work and GPU resource use independently; assess their interaction with application computation.
- **Message size:** A collective-specific byte quantity. Open MPI explicitly documents that its meaning depends on the collective. (docs.open-mpi.org)

Topology detection connects these dimensions. PyTorch documents NCCL's automatic tuning from detected topology. (docs.pytorch.org) A change in rank placement therefore deserves its own comparison rather than being buried inside an algorithm experiment. Open MPI's documentation separately discusses one-node and one-rank-per-node placements as conditions that can favor different algorithms. (docs.open-mpi.org)

For the operator, the recommended comparison key is: collective, datatype, reduction operator, byte convention, rank count, placement, runtime, provider, and buffer mode. Add the selected algorithm and protocol to that record after observing them. Treat any changed field as a possible explanation before attributing a performance difference to the algorithm name.

Ring, Tree, CollNet, and NVLS: Interpret the Path

NCCL Ring vs Tree

A **Ring AllReduce** can be understood through the logical combination of ReduceScatter and AllGather shown in the research presentation. (spcl.ethz.ch) The conceptual map below illustrates the phases, not cables, channel count, chunk boundaries, or a promise about the installed implementation.

```
Ring, simplified logical map:
rank A -> rank B -> rank C -> rank D -> rank A
reduced chunks circulate, then completed chunks circulate
conceptual phases: ReduceScatter -> AllGather
```

A **Tree** map emphasizes reduction toward a root and dissemination of the result. NVIDIA's historical Summit presentation describes complementary dual binary trees. (www.olcf.ornl.gov) The drawing shows a single simplified tree; it does not depict both complementary trees or their mapping onto local GPUs.

```
Tree, simplified logical map:
leaves -> intermediate ranks -> root
leaves <- intermediate ranks <- root
conceptual phases: reduction -> dissemination
```

These maps have deliberately bounded assumptions. They explain communication organization without assigning ranks to physical links. For an actual comparison, retain the detected graph and operation-level selection evidence. A generic expectation about latency or bandwidth is insufficient to establish whether a result is consistent with the installed topology. Open MPI's collective-tuning documentation independently warns that forcing one algorithm can bypass decisions suited to changing communicator or message sizes. (docs.open-mpi.org)

The diagnostic question should be concrete: does a representative latency region improve when the eligible AllReduce algorithm is restricted, while other inputs remain fixed? It should also state what would falsify the hypothesis, such as an improvement disappearing under matched placement or the restored automatic baseline.

CollNet and NVLS are qualified paths

CollNet uses a collective-network plugin; **NCCL_COLLNET_ENABLE=1** enables it, with default **0**. (docs.nvidia.com) Listing an accepted algorithm does not establish plugin eligibility. Pinned source maps the seven algorithm families to log labels such as **COLLNET_DIRECT** and **NVLS_TREE**, which differ from environment spellings. (github.com)

NVLS means **NVLink SHARP**, documented for third-generation NVSwitch, NVLink4, and Hopper or later. (docs.nvidia.com) A conceptual local map is:

```
NVLS, simplified supported-domain map:
participating GPU inputs
          -> NVSwitch reduction resources
          -> participating GPU results
```

The map does not establish the cross-node transport. Microsoft documents separate local NVLink and remote InfiniBand paths for its ND H100 v5 platform, illustrating why those boundaries must remain explicit. (learn.microsoft.com) AWS identifies EFA through a provider log, while Google documents specific NCCL/plugin combinations for GPUDirect-TCPX. Neither provider observation establishes NVLS selection. (docs.aws.amazon.com) (docs.cloud.google.com)

NCCL NVLS vs Ring

Treat this comparison as an eligibility and execution-path question before treating it as a speed comparison. Record whether NVLS resources initialized, whether the collective used the expected implementation, and whether registration conditions matched. Preserve the registration evidence alongside the selection record.

The research paper explicitly excludes detailed NVLS and CollNet analysis, so its Ring/Tree explanations should not be repurposed as a current NVLS benchmark. (arxiv.org) This report consequently provides no NVLS-versus-Ring performance ranking. A reproducible comparison must supply the missing hardware, software, and workload evidence.

Simple, LL, LL128, and the Versioned Control Ledger

NCCL LL vs LL128 vs Simple

Simple, **LL**, and **LL128** concern transfer organization and synchronization. In the paper's studied implementation, Simple uses memory fences for ordering; LL combines **4 data bytes** with a **4-byte flag**; LL128 places **120 data bytes** and **8 flag bytes** in a **128-byte unit**. (arxiv.org) (arxiv.org) These layouts explain why payload efficiency differs. They do not specify end-to-end throughput on a current cluster.

Historical NVIDIA material calls LL a low-latency, self-flagged protocol. (www.olcf.ornl.gov) Interpret that as a design purpose. The report recommends checking observed latency and correctness across the application's message range instead of converting the name into a universal crossover rule. Simple should likewise not be treated as an unsophisticated fallback solely because of its label.

The direct or staged data path adds another distinction. The research slides show a direct path without an intermediate staging buffer, which is a distinct dimension from the protocol name. (spcl.ethz.ch) Consequently, a protocol comparison should freeze allocation and registration behavior. If one run changes buffering as well as protocol, preserve it as a different experiment.

NCCL_PROTO accepts LL, LL128, and Simple case-insensitively; NVIDIA cautions against forcing unsupported LL128. (docs.nvidia.com) A diagnosis that disables a suspected protocol is a narrower question than trying to make an unsupported platform use it. Operators should establish supported eligibility before evaluating the performance observation.

Table 1 records the controls relevant to this report. Its scope is diagnostic; availability is not a recommendation to pin a setting.

Control	Verified version boundary or behavior	Diagnostic use and rollback
NCCL_ALGO	Ring, Tree, CollnetChain, CollnetDirect, NVLS, NVLSTree, PAT. Function-specific restrictions are available. (docs.nvidia.com)	Restrict one operation; restore unset baseline.
NCCL_PROTO	Log labels are LL, LL128, SIMPLE; confirm supported eligibility. (github.com)	Prefer a supported exclusion hypothesis.
NCCL_NVLS_ENABLE	Default **2**; unsupported hardware differs from failed resource allocation. (docs.nvidia.com)	Preserve initialization evidence.

Control	Verified version boundary or behavior	Diagnostic use and rollback
NCCL_DEBUG / SUBSYS	INFO plus TUNING reports choices; ATTN is unrecognized before **2.32**. (docs.nvidia.com)	Scope logs to the diagnostic window.
NCCL_DEBUG_FILE	Unique per-process filename patterns are recommended. (docs.nvidia.com)	Archive logs before cleanup.
Legacy thresholds/channels	LL_THRESHOLD/TREE_THRESHOLD removed in **2.5**; MIN/MAX_NCHANNELS deprecated in **2.17** for thread-block controls. (docs.nvidia.com)	Audit inherited settings.
nccl-tests -U	**0/1**, default **0**; tuning requires **2.28+**, extended fields **2.31+**. (raw.githubusercontent.com)	Record observer and profiler configuration.

Read the ledger against the **linked runtime**, not an assumed package version. For current NVLS, values **1/2** fail on allocation failure; **2.27/2.28** fallback was reverted in **2.29**. With multiple ranks sharing a GPU, **1** fails and **2** disables NVLS. (docs.nvidia.com) These distinctions require separate diagnoses.

Reading NCCL_DEBUG and Turning Symptoms into Hypotheses

Current NVIDIA logging documentation distinguishes **GRAPH**, **COLL**, **NET**, and **TUNING**. GRAPH concerns topology and communication patterns; COLL concerns collective calls; NET concerns transport; TUNING concerns algorithm and protocol selection. (docs.nvidia.com) PyTorch also identifies COLL logs as useful for collective-type or message-size mismatches and GRAPH logs for topology inspection. (docs.pytorch.org)

An initialization log showing a constructed Ring tells the reader that a pattern exists. It does not, by itself, identify the execution path for every subsequent operation. The current NVIDIA example instead shows a per-operation TUNING record:

```
AllReduce: 33554432 Bytes -> Algo RING proto SIMPLE channel{Lo..Hi}={0..31}
```

This is a **documentation example**, not a measurement from this report. The byte count, algorithm, protocol, and channel range appear together in the opened source. (docs.nvidia.com) Operators should preserve the surrounding runtime and rank context before comparing a similar line with another run.

The pinned nccl-tests implementation provides another observation channel. With **-U 1**, output includes implementation, algorithm, protocol, kernel variant, synchronization strategy, channels, warps, and network chunk size where available; symmetric (**SYM**) events populate algorithm and protocol as not applicable (**N/A**), while generic (**GEN**) events report them. Missing conventional algorithm labels can therefore be consistent with a symmetric implementation. (raw.githubusercontent.com) The option also interacts with profiler configuration, so its observer state belongs in the experiment manifest. (raw.githubusercontent.com)

Table 2 converts common symptoms into evidence requests. These are diagnostic hypotheses, not prescribed tuning values.

Symptom	Evidence to inspect first	Bounded hypothesis and stop condition
Small-message latency	Operation, sizes, selected implementation, algorithm/protocol, launch context.	Compare a supported restriction. Stop if benefit disappears in representative application timing.
Large-message bandwidth	Correct byte convention, selected path, provider, resource usage. (docs.aws.amazon.com)	Test one restriction. Stop if it consumes resources without an application gain.
Rank or topology asymmetry	Physical identities, visible-device mapping, graph and processor/device locality. (slurm.schedmd.com) (kubernetes.io)	Hold selection automatic while isolating placement. Stop if algorithm changes conceal the placement difference.
Correctness error or mismatch	Datatype, count, collective order and checker output. (docs.pytorch.org)	Resolve semantic or configuration mismatch before performance comparison.
Unexpected transport	NET/provider evidence and installed plugin/runtime pair. (docs.aws.amazon.com) (docs.cloud.google.com)	Verify intended provider before testing Ring against Tree.

The order matters. A provider difference is a transport hypothesis; a visible-device remapping is a placement hypothesis. Slurm documents that job-step CUDA visibility can differ from physical indexing and that **NVIDIA Management Library (NVML)** numbers follow **Peripheral Component Interconnect (PCI)** bus ordering. (slurm.schedmd.com) Kubernetes documents additional latency when central processing unit (CPU) and device allocation land on different non-uniform memory access (NUMA) nodes. (kubernetes.io) Both are reasons to preserve identities and locality rather than comparing only rank labels.

For process confinement, Linux documents **cpuset.cpus.effective** as the CPUs actually granted to a cgroup. (docs.kernel.org) Record that effective set alongside the launcher request. Treat the discrepancy between requested and effective resources as evidence to explain, without assuming that it requires a collective override.

A Controlled NCCL_ALGO and NCCL_PROTO Experiment

The report recommends a small, reversible comparison with a named owner and a written question. The purpose is to distinguish an algorithm/protocol effect from a changed environment. The working hypothesis is that a gain in an isolated test still needs application confirmation. Open MPI's parallel discussion of forced selection reinforces the need to retain automatic decisions as a comparison arm. (docs.open-mpi.org)

Use the following **override experiment card**:

- **Question:** Name the collective, message region, symptom, and expected mechanism.
- **Baseline:** Preserve the complete automatic-selection run and its raw output.
- **Software:** Record linked NCCL, CUDA, driver, framework, network plugin, and test commit. Verify the commit with Git's current-object command. (git-scm.com)
- **Placement:** Freeze nodes, GPU physical identities, rank mapping, and effective CPU allocation. (slurm.schedmd.com) (docs.kernel.org)
- **Operation:** Match datatype, reduction operator, count convention, and in-place or out-of-place mode.
- **Buffers:** Preserve allocation and registration mode.

- **Observer:** Keep identical logging, profiler, and tuning-output settings across arms.
- **Intervention:** Change one algorithm restriction or one protocol restriction.
- **Correctness:** Require the test checker to pass before interpreting timing.
- **Sampling:** Repeat matched runs and retain variation, not merely the fastest result.
- **Application:** Confirm the effect in the workload's collective mix and computation context.
- **Rollback:** Restore automatic selection, rerun it, and compare with the original baseline.
- **Disposition:** State supported scope, unresolved differences, and why the override was retained or removed.

The pinned README documents **-b/-e** for the byte range, **-f** for multiplicative steps, **-g** for GPUs per thread, **-n** for timed iterations, **-w** for warmup, and **-c** for correctness iterations. (raw.githubusercontent.com) Keep identical process, thread, and GPU counts in every comparison arm.

Illustrative command card (Hypothetical Example). This local command template requires at least two visible CUDA GPUs. It runs one process with one thread and two GPUs per thread, giving two ranks for inter-rank comparisons. It is not a cluster launcher or a recommended application message range. The numerical arguments are explicit experimental inputs, not performance targets. (NVIDIA nccl-tests README)

```
env -u NCCL_ALGO -u NCCL_PROTO \
  NCCL_DEBUG=INFO \
  NCCL_DEBUG_SUBSYS=INIT,ENV,GRAPH,NET,COLL,TUNING \
  NCCL_DEBUG_FILE=nccl.%h.%p.log \
  ./build/all_reduce_perf \
  -b 8 -e 128M -f 2 -t 1 -g 2 -n 20 -w 5 -c 1 -U 1
```

Preserve per-process logs and explicit flag values with the command card. Clearing inherited process variables is only part of baseline reconstruction: record any configuration or plugin settings injected elsewhere and confirm the observed selection. Multi-node execution additionally needs the MPI-enabled nccl-tests build and the platform's launcher configuration. (raw.githubusercontent.com)

For the algorithm arm, an example restriction is **NCCL_ALGO='allreduce:Ring'**. For a suspected supported-protocol issue, an example exclusion is **NCCL_PROTO='allreduce:^LL128'**. (docs.nvidia.com) Keep the other dimension at baseline. The expanded selection syntax and stricter enforcement were introduced in **2.24**. (docs.nvidia.com) Verify that the eligible set still covers every requested operation.

Rollback should occur when correctness fails, the intended selection is unobserved, topology/provider inputs drift, or the application benefit is absent. A maintained exception should include its rationale and expiry trigger, such as a runtime or plugin upgrade. It should not silently become a cluster-wide default.

Data Analysis and Evidence

The numerical core is interpretation, not a benchmark ranking. The pinned nccl-tests documentation defines **algbw = S/t**, using the operation's byte size and elapsed time. It derives **busbw** through a collective-specific correction. (raw.githubusercontent.com) Open MPI's separate message-size warning is a useful reminder that matching the printed byte number is insufficient unless the operation's definition matches. (docs.open-mpi.org)

Table 3 states the documented corrections, where **n** is rank count. For AllGather and ReduceScatter, **S** is the total-array size rather than one rank's slice.

Collective	Size convention	nccl-tests busbw
AllReduce	Collective array bytes, S.	algbw × **2(n-1)/n**. (raw.githubusercontent.com)
AllGather	sendcount × datatype bytes × n.	algbw × **(n-1)/n**. (raw.githubusercontent.com)
ReduceScatter	recvcount × datatype bytes × n.	algbw × **(n-1)/n**. (raw.githubusercontent.com)
Broadcast	Broadcast payload bytes.	**algbw**, correction factor **1**. (raw.githubusercontent.com)
Reduce	Reduced array bytes.	**algbw**, correction factor **1**. (raw.githubusercontent.com)

These formulas make busbw a normalized interpretation of collective work. The documentation qualifies its transfer derivation by point-to-point send/receive operations. (raw.githubusercontent.com) Accordingly, a hardware reduction path needs additional evidence before busbw is equated to measured switch-port traffic or a physical link utilization percentage. Preserve counters separately and identify exactly what they measure.

Calculated rank example (Hypothetical Example). At **n = 8**, the AllReduce factor is **1.75**, while the AllGather/ReduceScatter factor is **0.875**, by substitution into the documented equations. (raw.githubusercontent.com) Different normalized values can therefore describe the same algbw without implying different measured physical-link capacity.

The protocol layouts yield a second calculation: LL's payload fraction is **4/8 = 50%**, and LL128's is **120/128 = 93.75%** in the studied implementation. (arxiv.org) (arxiv.org) These fractions exclude launch, synchronization, buffering, contention, and topology effects. They should not be converted into a predicted speedup.

Check units in the actual output. The pinned executable source labels time in **microseconds (us)** and bandwidth in **gigabytes per second (GB/s)**, although the introductory performance-document prose says **milliseconds (ms)**. This is a documentation/source discrepancy; the executable header is the stronger guide to interpreting that output. (raw.githubusercontent.com) (raw.githubusercontent.com) Preserve the header with every exported result.

Finally, preserve measurement provenance. The research paper reports **20 runs with warmup per data point**. (arxiv.org) CSCS documents Alps' Slingshot-11 interconnect at **200 gigabits per second (Gbps) injection bandwidth per module/GPU**. (www.cscs.ch) Those source-specific conditions illustrate why published observations cannot supply a current cluster's universal crossover. Record the tested system and the version studied alongside the graph, then compare only what those conditions support.

Implications and Future Directions

For performance teams, use the evidence package to decide which layer needs further investigation. The Linux PCI peer-to-peer documentation explains that forwarding across hierarchy domains is not universally defined, a topology caution rather than a direct test of NCCL eligibility. (docs.kernel.org) Use actual CUDA/NCCL evidence to establish the GPU path.

For cluster buyers, keep local GPU communication and cross-node transport separate when requesting remediation evidence. Microsoft’s documented separation of local NVLink and remote InfiniBand illustrates the physical boundary that such evidence should preserve. (learn.microsoft.com)

For platform owners, changes should create a new comparison branch. Google documents a specific NCCL/plugin combination for GPUDirect-TCPX. (docs.cloud.google.com) PyTorch notes that some NCCL socket settings are already pre-tuned for cloud providers. (docs.pytorch.org) Copying another platform's environment block therefore requires a new eligibility and workload assessment, not an assumption that the settings are portable.

The following practices keep diagnostic conclusions maintainable:

- **Date the evidence:** Preserve the linked runtime and source revision, including the immutable test commit. (git-scm.com)
- **Separate scopes:** Preserve placement and effective allocation, including scheduler or container constraints. (kubernetes.io) (docs.kernel.org)
- **Preserve application context:** Evaluate communication resource use alongside computation. (docs.nvidia.com)
- **Avoid inherited rankings:** Re-evaluate algorithm decisions after topology or workload changes. (docs.open-mpi.org)
- **Avoid cloud-block copying:** Revalidate the provider/plugin combination before adopting platform settings. (docs.cloud.google.com)
- **Avoid stale controls:** Check installed-version documentation rather than assuming a knob from an earlier release still applies.

Current release notes also show why new hardware support and mature tuning should be distinguished: the pinned release notes initial Rubin support while explicitly excluding Rubin performance-model tuning. (github.com) That is a documented release boundary, not a forecast of measured performance.

GPU Smith's first-party documentation lists architecture records, port maps, operating procedures, and acceptance reports. (gpusmith.com) Keep these records usable across operator handovers.

Frequently Asked Questions (FAQs)

What are NCCL algorithms and protocols?

Algorithms organize collective communication; protocols govern transfer and synchronization. Ring and Tree belong to the first dimension; Simple, LL, and LL128 belong to the second. Transport is separately represented in the research taxonomy. (spcl.ethz.ch)

Is Tree always better for small messages and Ring for large messages?

This report establishes no universal boundary. Collective libraries document situation-dependent algorithm performance, and placement changes can alter the preferred algorithm. Use the installed topology and representative message mix to test the hypothesis. (docs.open-mpi.org) (docs.open-mpi.org)

Can NCCL_DEBUG show the chosen algorithm?

Use operation-level selection records rather than inferring execution from a graph alone. The pinned nccl-tests tuning output supplies implementation and protocol fields where available. (raw.githubusercontent.com)

Should NCCL_ALGO or NCCL_PROTO stay set after diagnosis?

Use the experiment card's Application, Rollback, and Disposition fields to decide whether a setting remains justified.

Does a floating-point difference establish a correctness fault?

Not automatically. The MPI standard explains that evaluation order can affect floating-point reductions because addition is not strictly associative. Compare against the application's defined numerical requirements while requiring the test's checker to pass. Do not use that observation to dismiss arbitrary wrong results. (www.mpi-forum.org)

Conclusion

Ring and Tree diagrams help explain organization, while Simple, LL, and LL128 explain a different transfer dimension. NVLS and CollNet add qualified paths whose eligibility requires specific evidence. None of those labels alone establishes the expected speed of an application or the condition of a fabric.

Use the control ledger and symptom table to choose the next evidence request, and the experiment card to record the result and its supported scope. A diagnostic outcome should identify which layer warrants further investigation before operators or buyers commit to node or fabric remediation.

Source links

Links cited in this article, in order of first appearance. Full addresses are provided for readers using extracted text.

1. https://spcl.ethz.ch/Publications/.pdf/hu-demystifying-nccl-slides.pdf
2. https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/efa-start-nccl.html
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About GPU Smith

GPU Smith provides independent engineering and research for private AI infrastructure. We help technical buyers and operators reason about GPU workload sizing, hardware selection, procurement, deployment and inference operations, from the compute system to the networking, power and cooling requirements around it.

Start with the workload

Useful infrastructure decisions begin with the models, data, throughput, latency and operating constraints a team actually has. GPU Smith helps connect those requirements with system design and deployment choices. The goal is a privately controlled AI environment whose capacity and operational demands are understood before a purchasing decision.

Hardware and supplier research

Our public reference library covers GPUs, complete systems and networking components. The server-vendor directory and manufacturing research help teams investigate suppliers, compare options and follow sources behind technical claims. We distinguish manufacturer specifications from measured benchmarks and advertised capabilities from tested configurations. Reference pages are research resources, not a live inventory listing or a binding equipment quote.

Deployment and operations

GPU Smith's engineering scope includes infrastructure integration, networking, power, cooling and the practical operation of inference workloads. Our published articles explain the tradeoffs behind deployment, procurement and ongoing operations so teams can ask better questions and document decisions.

Work with GPU Smith

Explore the hardware library, GPU references, networking references and vendor research. Contact GPU Smith with your workloads and deployment constraints to discuss a project and confirm current scope, pricing and availability.

Inclusion of a manufacturer or product in our research does not imply a partnership, certification or endorsement.

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