ROCm Support in UCX

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Features added/in-progress

- ROCm memory support for perf tools
- Remove dependency on GDRCopy module
- SSE based memcpy for small messages
- Improved agent selection for IPC transfers
- Staged D2D transfers for inter-node
- Added Hardware Tag Matching support

ROCm memory support for perf tools

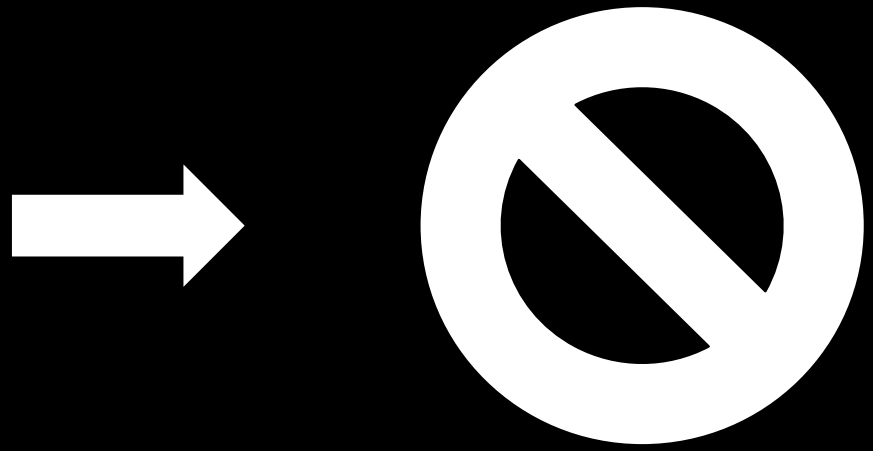
```
$ ./bin/ucx_perftest localhost -f -c 2 -t tag_lat -m rocm
+--------------+-----------------------------+---------------------+-----------------------+
|              |       latency (usec)        |   bandwidth (MB/s)  |  message rate (msg/s) |
+--------------+---------+---------+---------+----------+----------+-----------+-----------+
| # iterations | typical | average | overall |  average |  overall |   average |   overall |
+--------------+---------+---------+---------+----------+----------+-----------+-----------+
       1000000     1.433     7.848    11.025       0.97       0.69      127413       90702
$ ./bin/ucx_perftest localhost -f -c 2 -t tag_lat -m host,rocm
+--------------+-----------------------------+---------------------+-----------------------+
|              |       latency (usec)        |   bandwidth (MB/s)  |  message rate (msg/s) |
+--------------+---------+---------+---------+----------+----------+-----------+-----------+
| # iterations | typical | average | overall |  average |  overall |   average |   overall |
+--------------+---------+---------+---------+----------+----------+-----------+-----------+
       1000000     0.792     2.302     2.338       3.31       3.26      434408       427652
$ ./bin/ucx_perftest localhost -f -c 2 -t tag_lat -m rocm,host
+--------------+-----------------------------+---------------------+-----------------------+
|              |       latency (usec)        |   bandwidth (MB/s)  |  message rate (msg/s) |
+--------------+---------+---------+---------+----------+----------+-----------+-----------+
| # iterations | typical | average | overall |  average |  overall |   average |   overall |
+--------------+---------+---------+---------+----------+----------+-----------+-----------+
       1000000     0.775     2.284     2.292       3.34       3.33      437768       436257
```

- UCX perftest now supports ROCm memory (#4587)
- Added support for measuring D2H/H2D transfers (#4607)

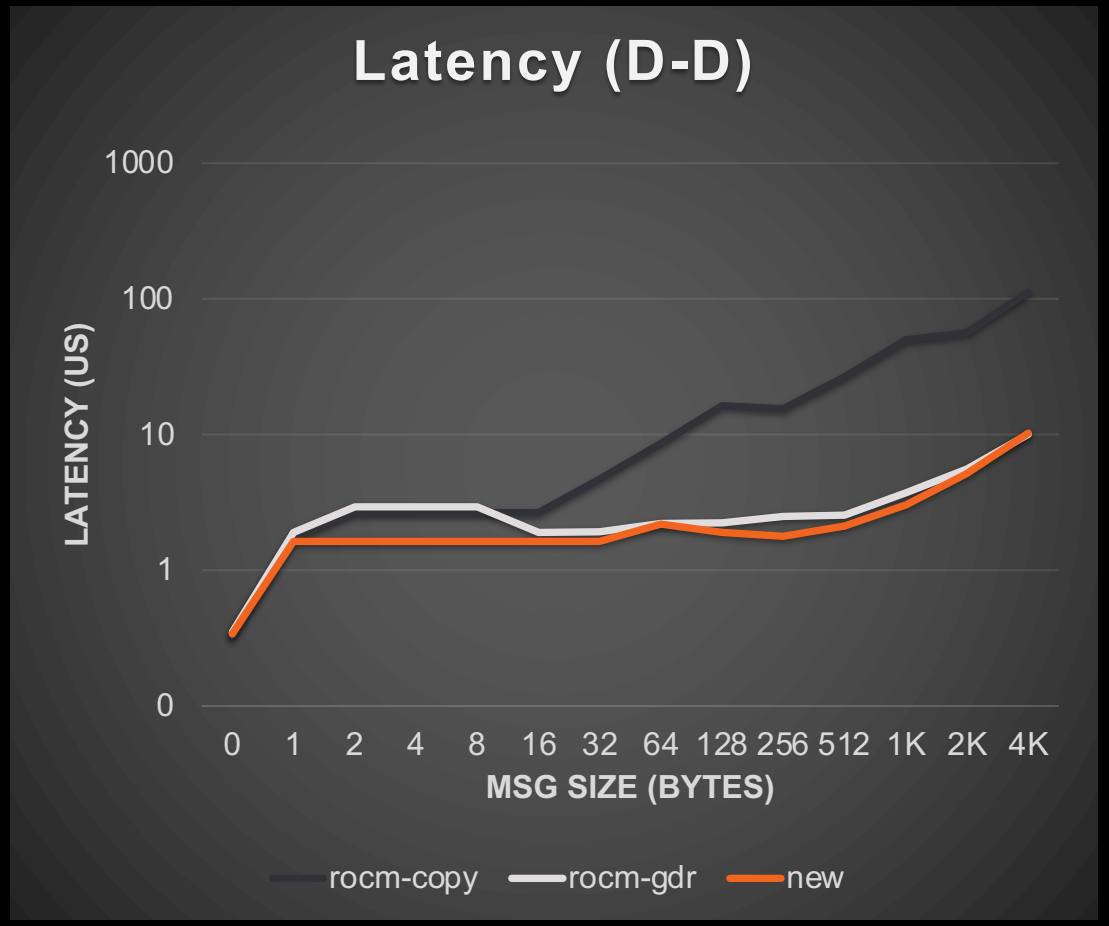
Remove dependency on GDRCopy

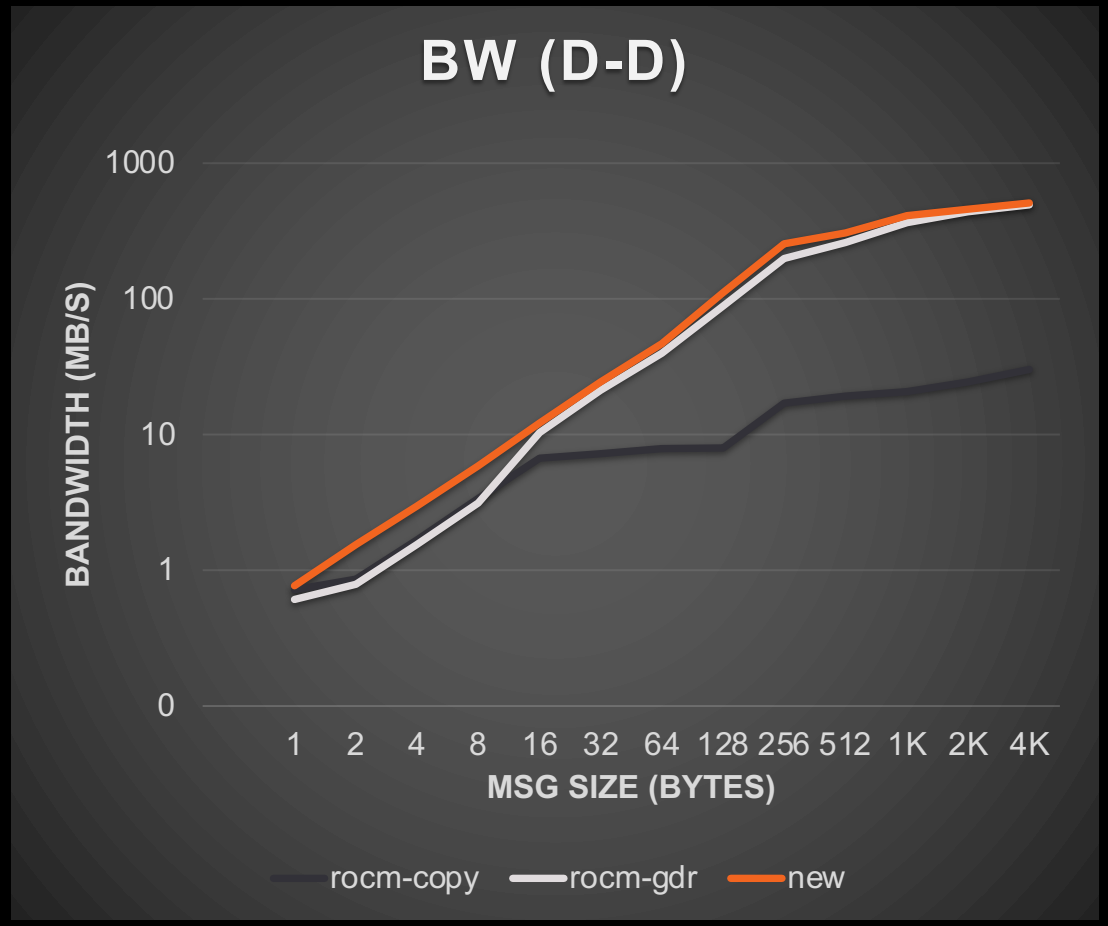
- No need for GDRCopy module to be installed
- Integrated into rocm_copy module (#4532)

```
export GDR_DIR=$INSTALL_DIR/gdr export
LD_LIBRARY_PATH=$GDR_DIR/lib64:$LD_LIBRARY_PATH
git clone https://github.com/NVIDIA/gdrcopy.git
cd gdrcopy
git checkout -b v1.3 tags/v1.3
mkdir -p $GDR_DIR/lib64 $GDR_DIR/include
make PREFIX=$GDR_DIR lib install
configure --with-gdrcopy=$GDR_DIR …
```



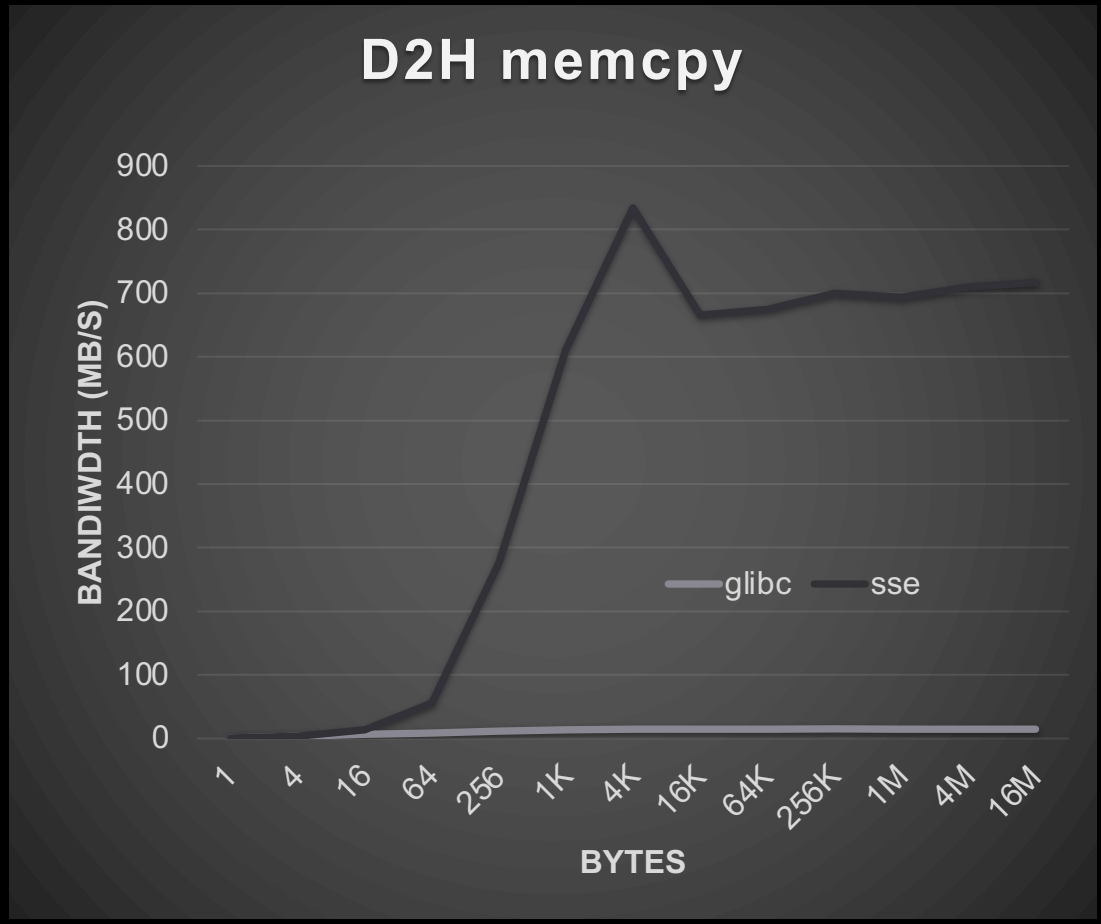
With no degradation in performance!



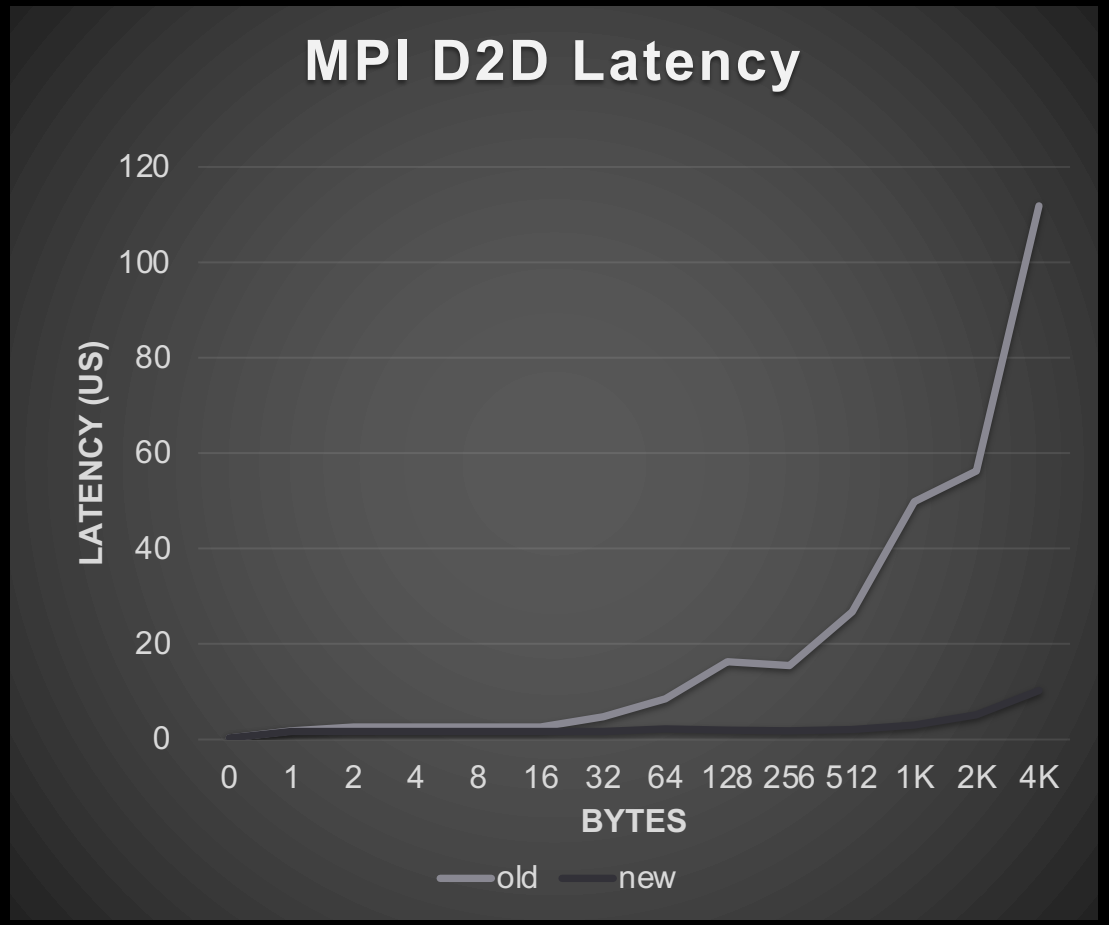


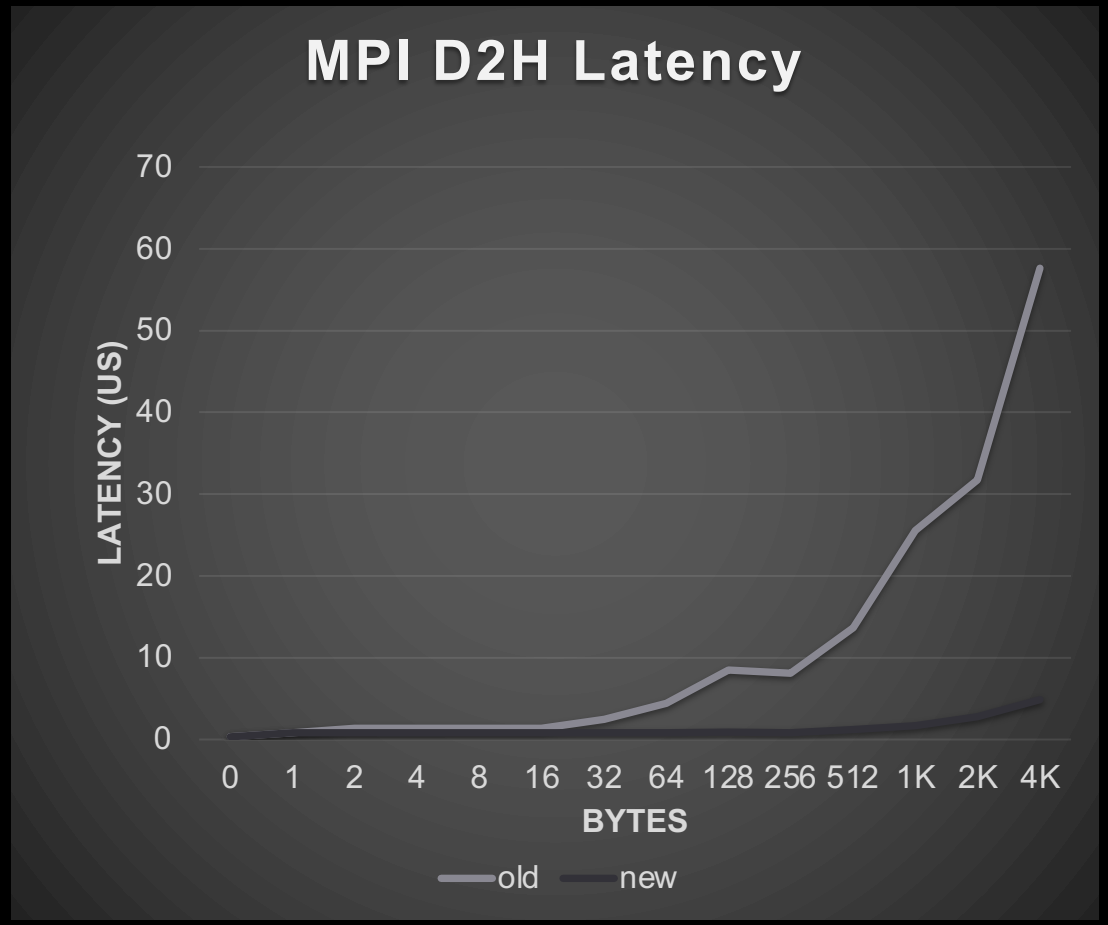
SSE based memcpy for small messages

- glibc memcpy is slow for D2H
- Did exhaustive study of the performance of vectorized copy intrinsics
- Added Non-temporal instruction based memcpy (#4532)
- Up to 50x faster than baseline

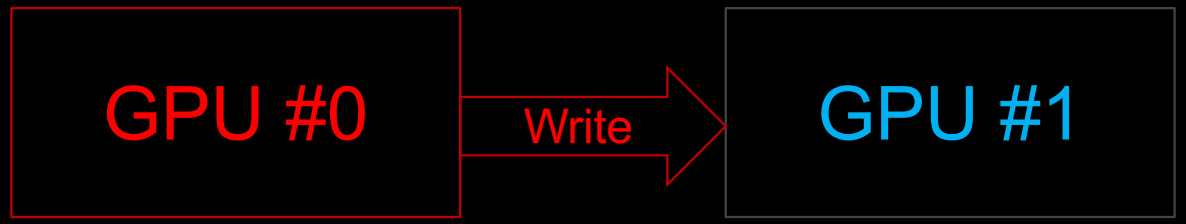


SSE based memcpy for small messages

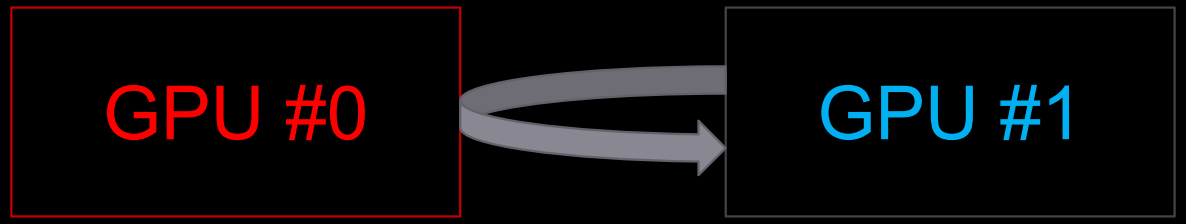




Improved agent selection for IPC transfers

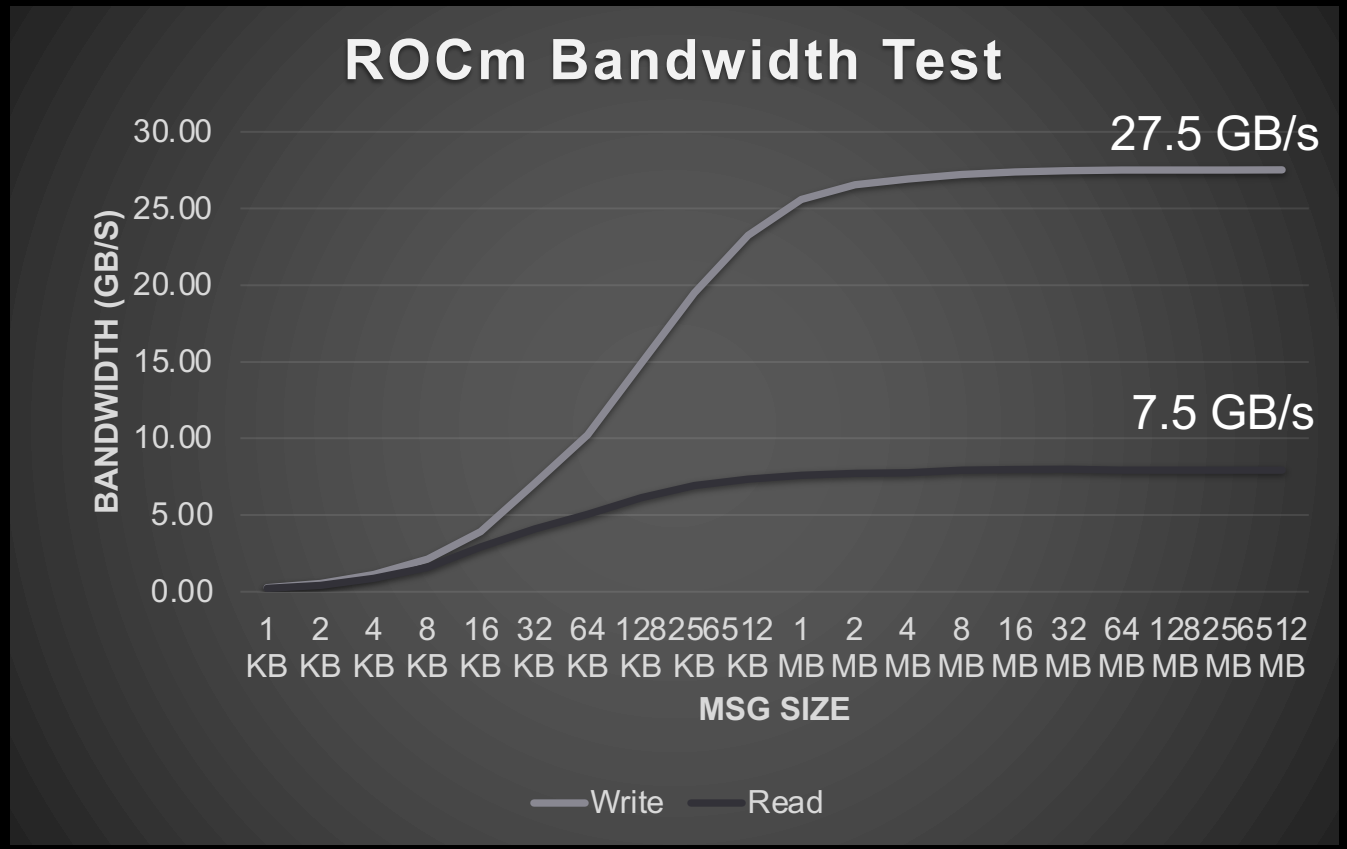


Local Read Remote Write (LRRW)



Remote Read Local Write (LRRW)

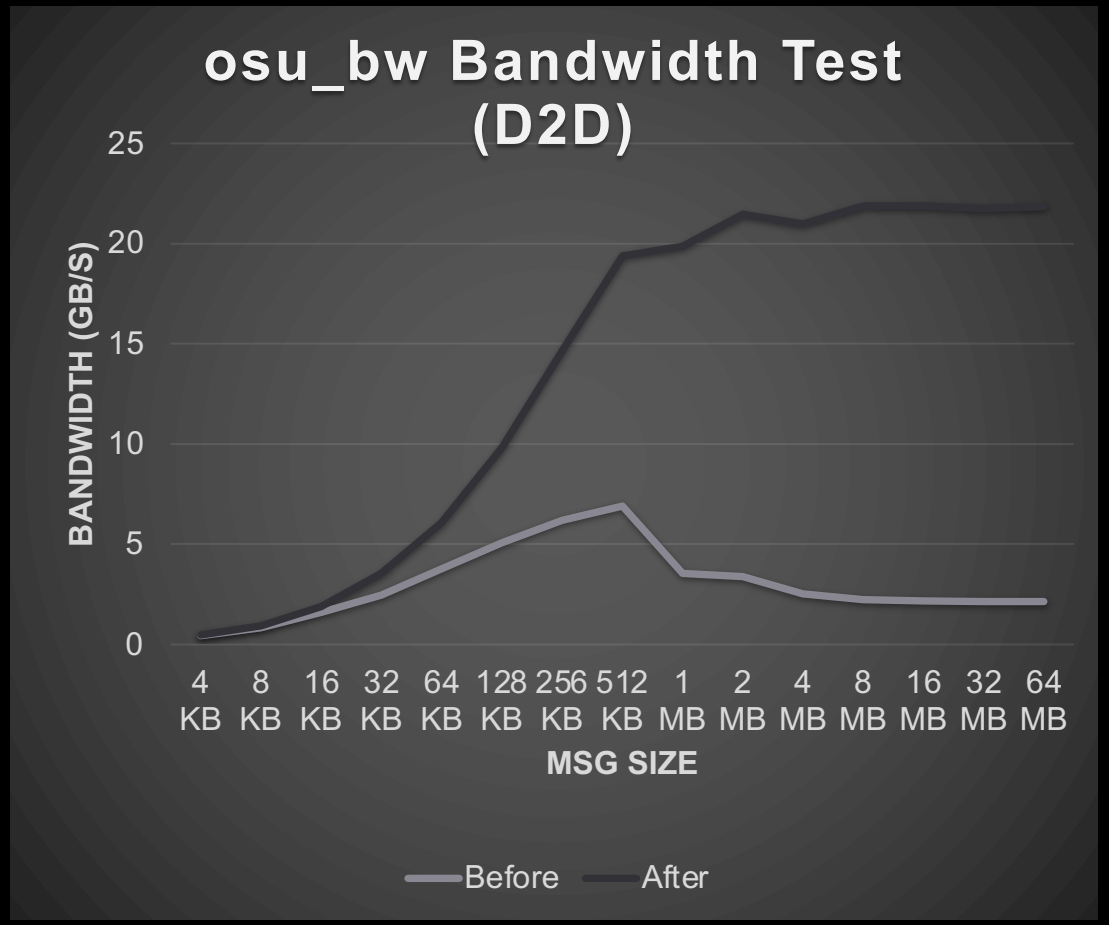
Read / Write bandwidth over PCIe 4.0



- Read performs worse than Write
- get_zcopy performance is worse than put_zcopy
- How to make get_zcopy better?

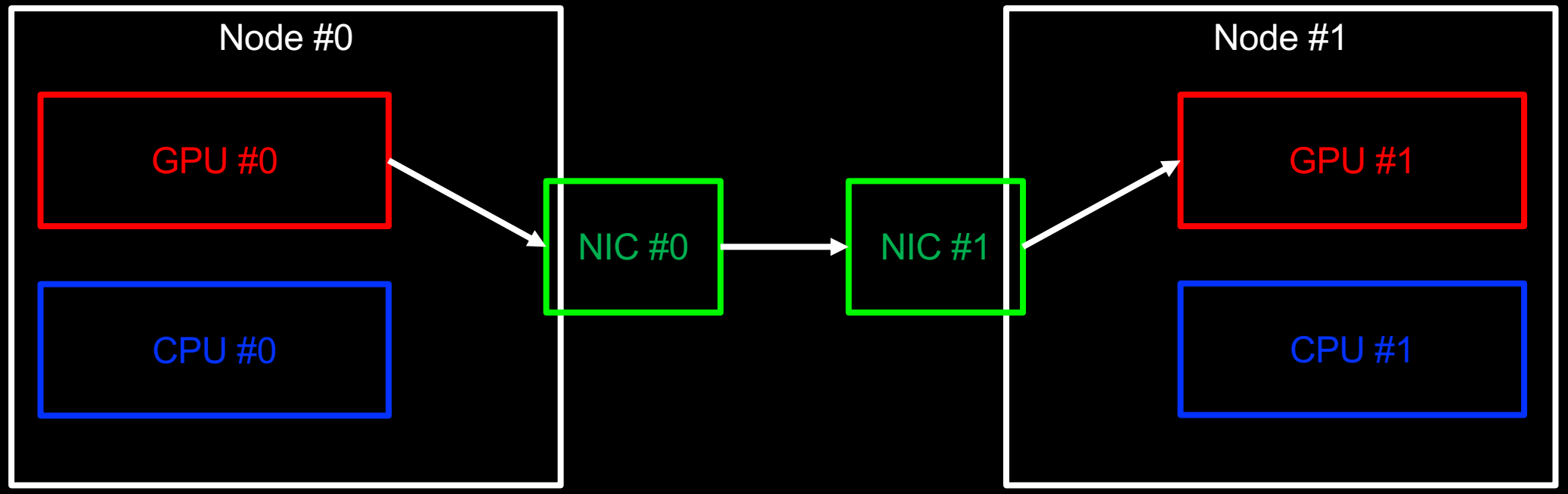
- Only PCIe systems are affected

Improved agent selection for IPC transfers

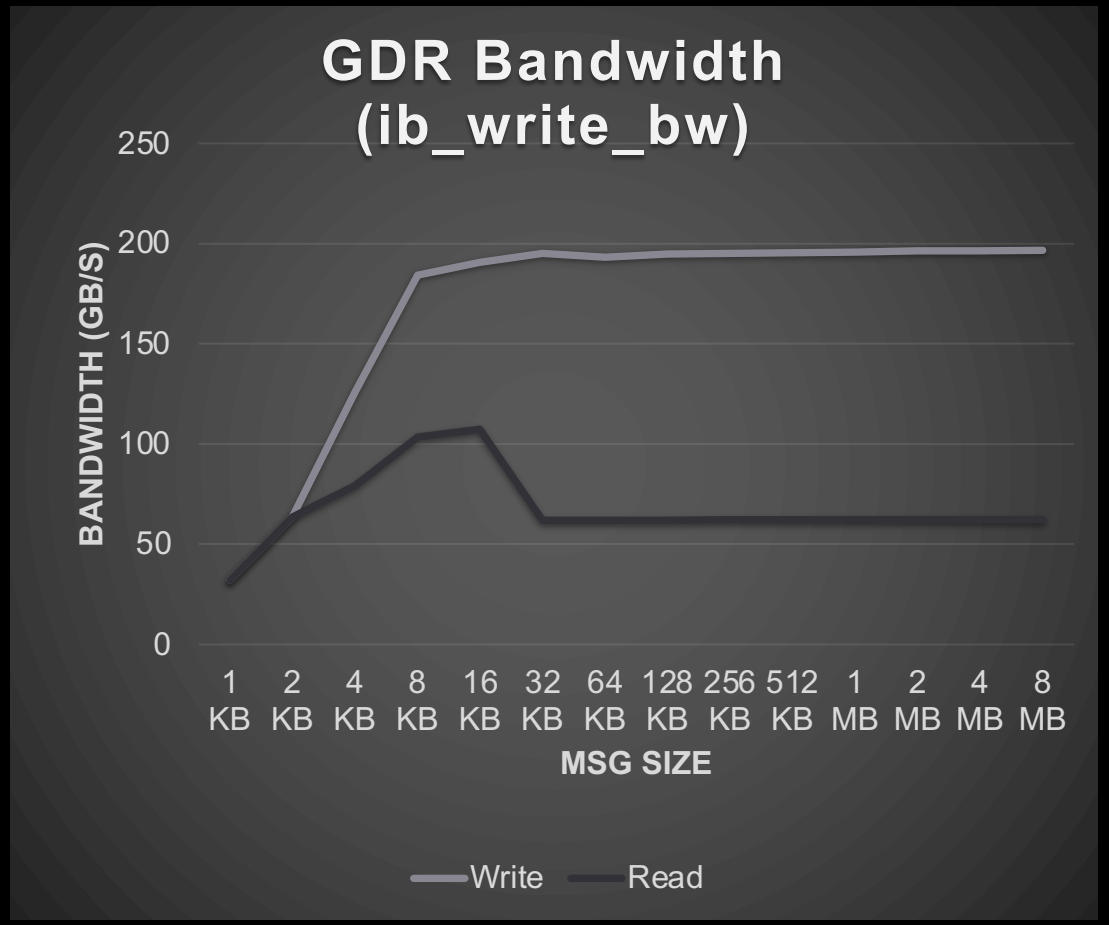


- Solution: issue write from the source GPU using ROCR/HSA
- Limitation: Doesn’t work if both devices are not visible to both processes

D2D transfers for inter-node using GDR

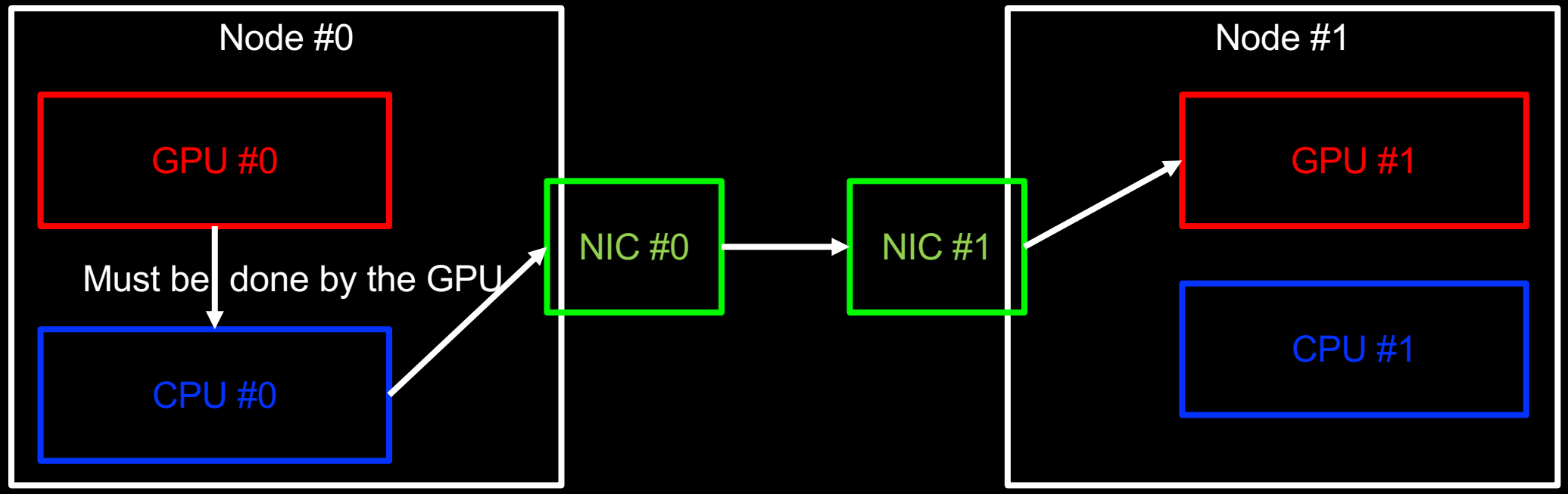


GDR Read/Write performance



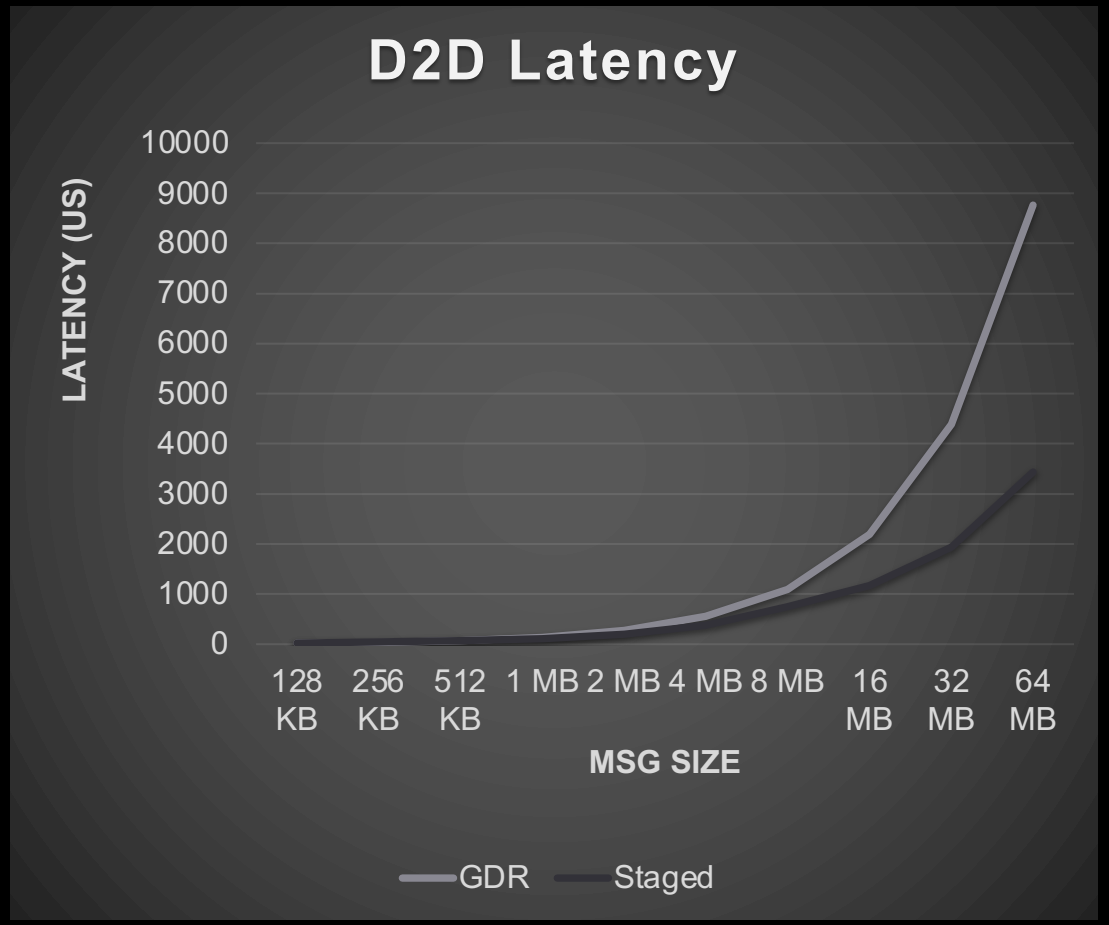
- GDR Writes can saturate line rate (~200 Gb/s)
- GDR Reads are slow due to PCIe limitations (~60/120 Gb/s)
- Performance depends on PCIe root complex sharing between GPU and NIC
- put_zcopy doesn't help here because the NIC still needs to read from the source GPU#0

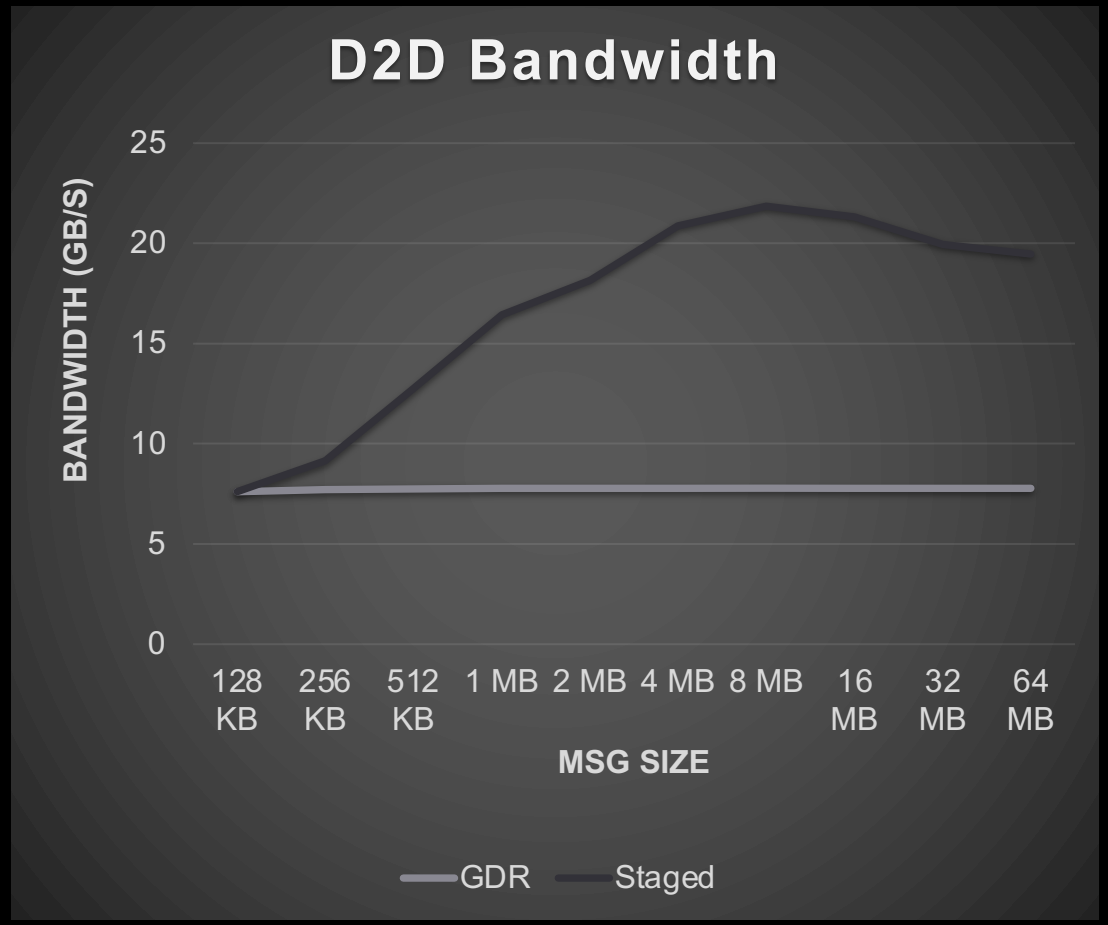
Staged D2D transfers for inter-node



Initial Support: @bureddy et al
Add ROCm support: #5742

Staged D2D transfers for inter-node





What's next?

- Support for MPICH

What we are looking forward to?

- Heterogenous topology support
  - How to detect and encode link type? (PCIe/Infinity Fabric/NVLink)
  - How to encode distance between PCIe devices?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