

Programming OpenMP

OpenMP and MPI

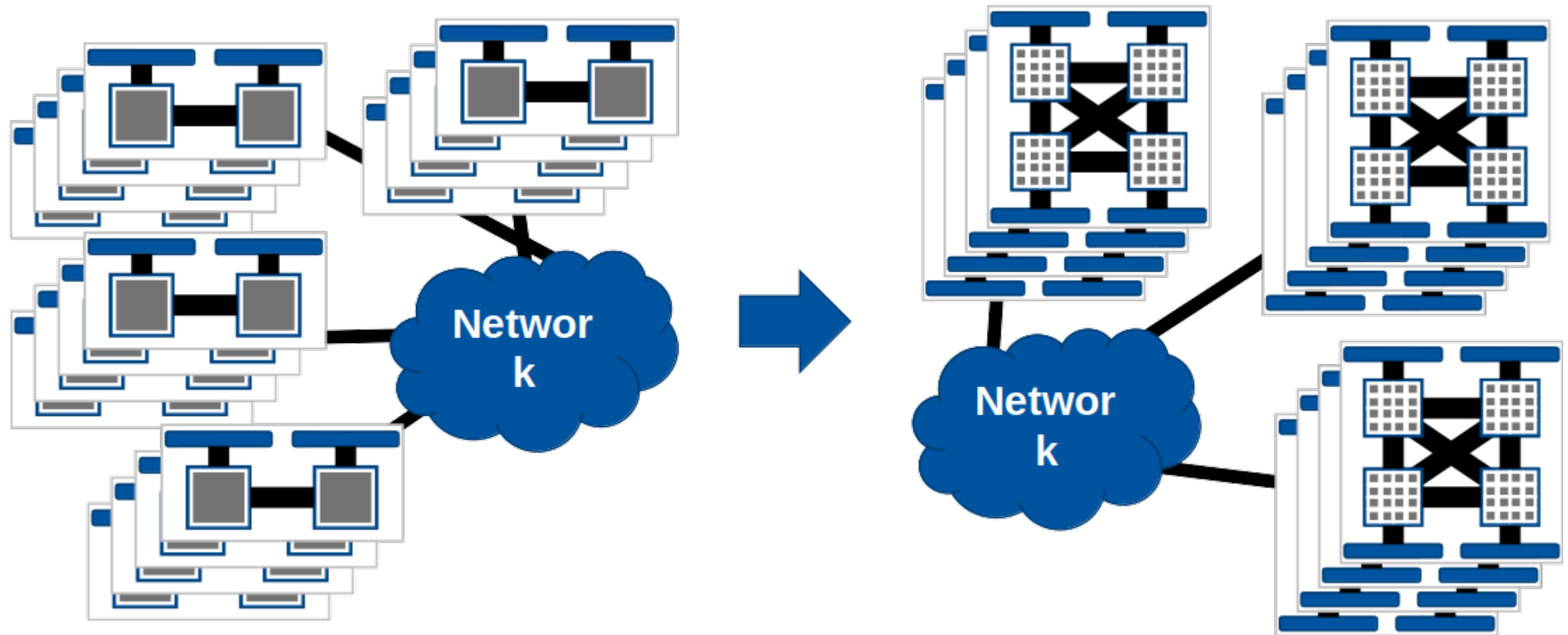
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Motivation

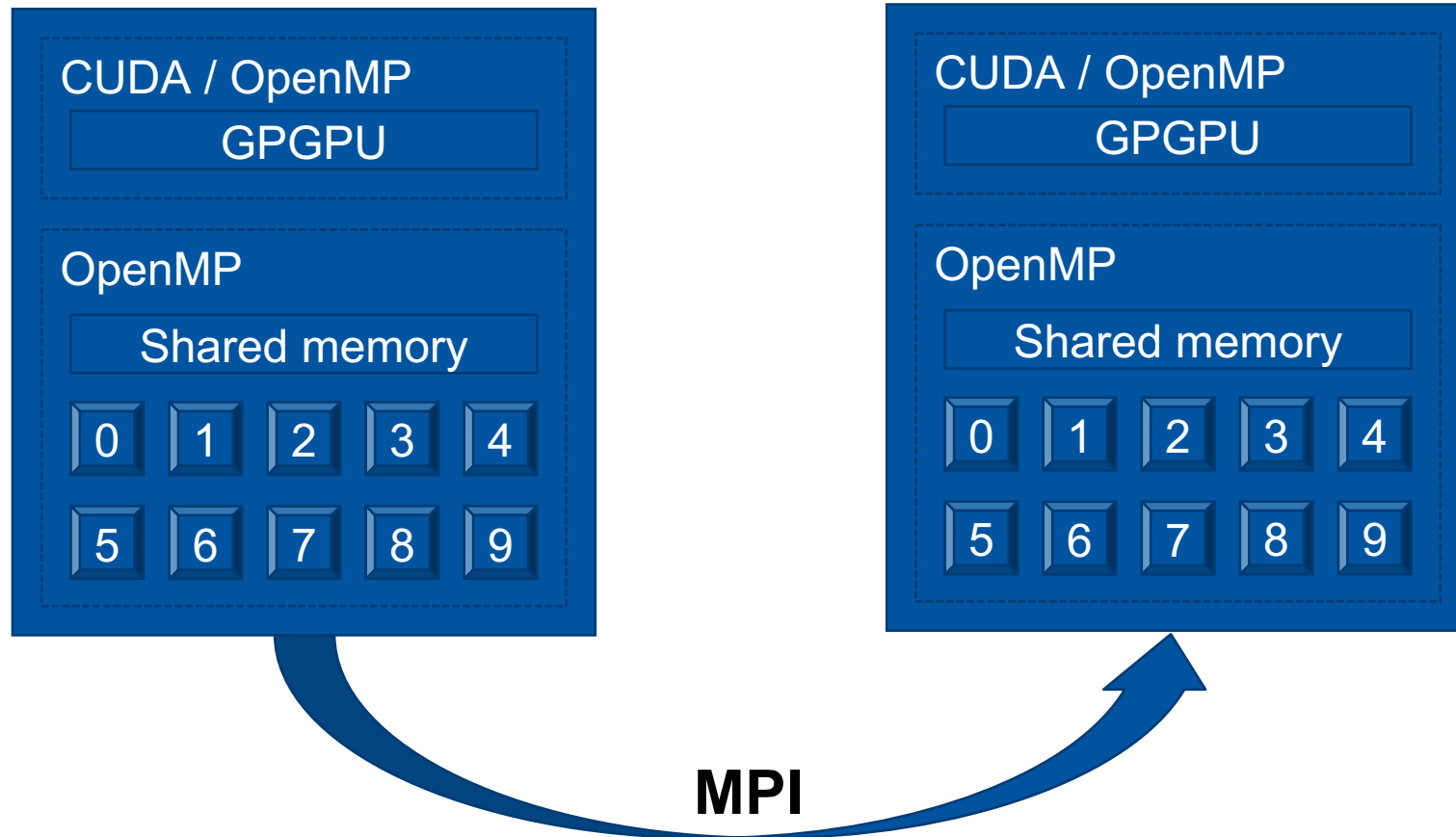
Motivation for hybrid programming

- Increasing number of cores per node



Hybrid programming


- (Hierarchical) mixing of different programming paradigms



MPI and OpenMP

MPI – threads interaction

- MPI needs special initialization in a threaded environment
 - Use `MPI_Init_thread` to communicate thread support level
- Four levels of threading support

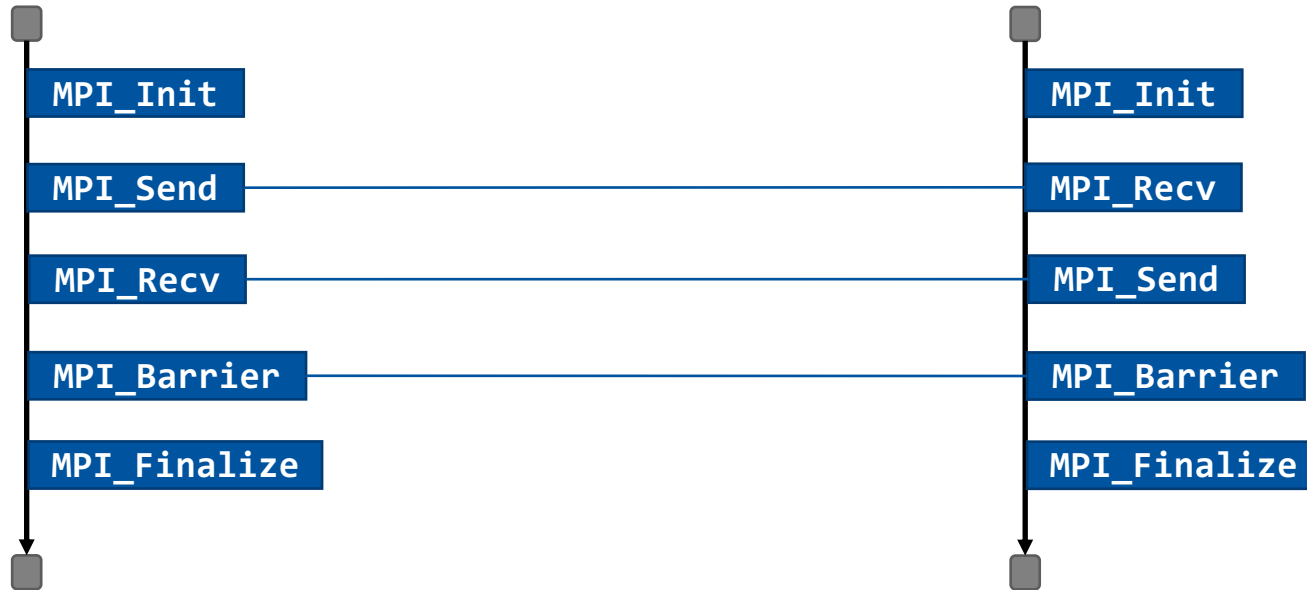
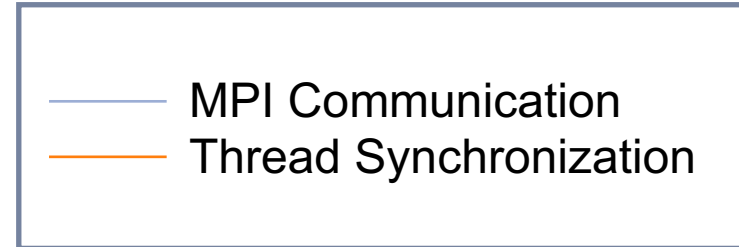


Level identifier	Description
<code>MPI_THREAD_SINGLE</code>	Only one thread may execute
<code>MPI_THREAD_FUNNELED</code>	Only the main thread may make MPI calls
<code>MPI_THREAD_SERIALIZED</code>	Any one thread may make MPI calls at a time
<code>MPI_THREAD_MULTIPLE</code>	Multiple threads may call MPI concurrently with no restrictions

- `MPI_THREAD_MULTIPLE` may incur significant overhead inside an MPI implementation

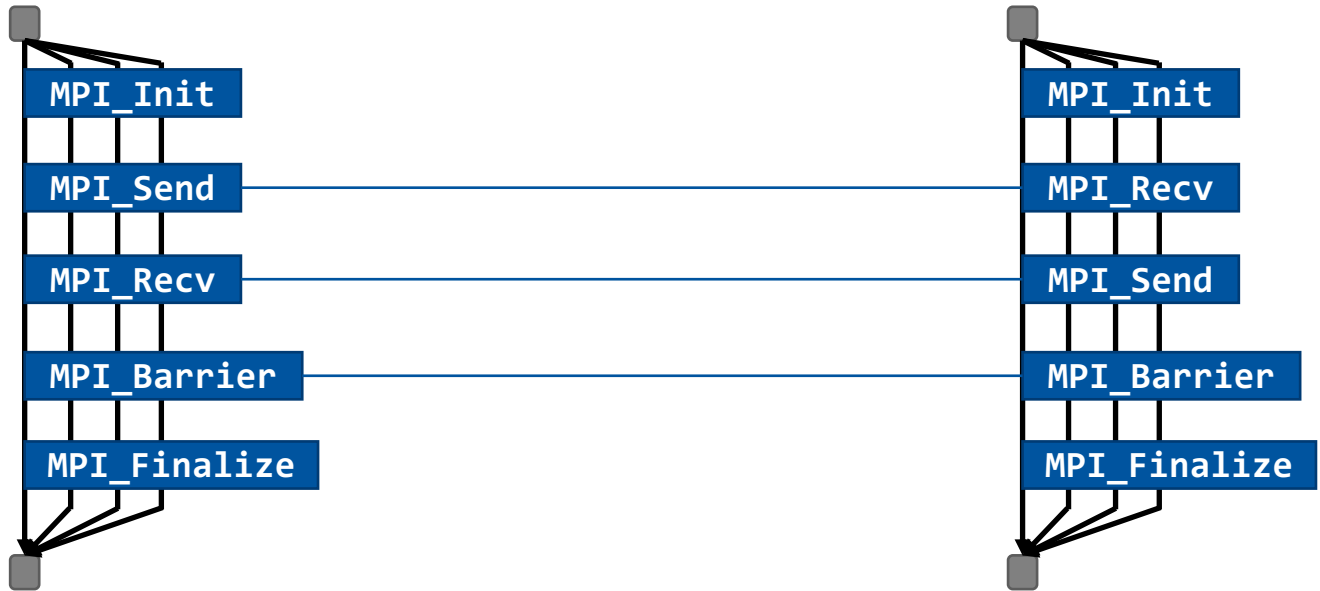
MPI – Threading support levels

- MPI_THREAD_SINGLE
 - Only one thread per MPI rank



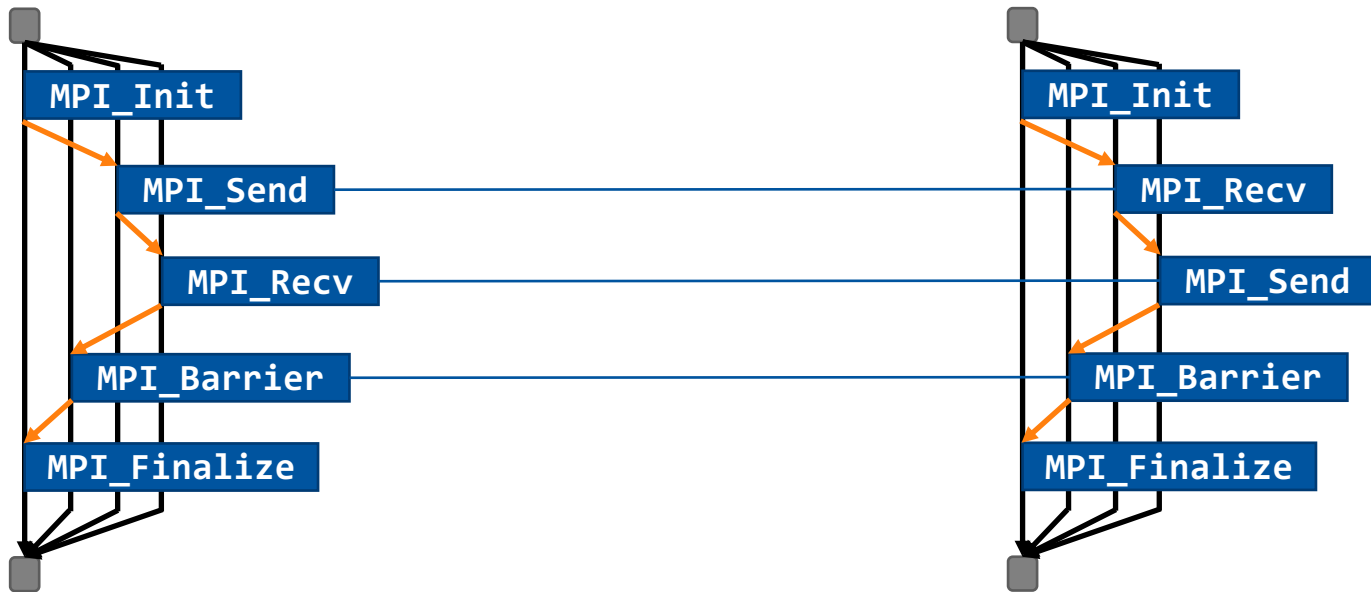
MPI – Threading support levels

- MPI_THREAD_FUNNELED
 - Only one thread communicates



MPI – Threading support levels

- MPI_THREAD_SERIALIZED
 - Only one thread communicates at a time



MPI – Threading support levels

- MPI_THREAD_MULTIPLE
 - All threads communicate concurrently without synchronization

