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JÜLICH
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MultiGPU programming

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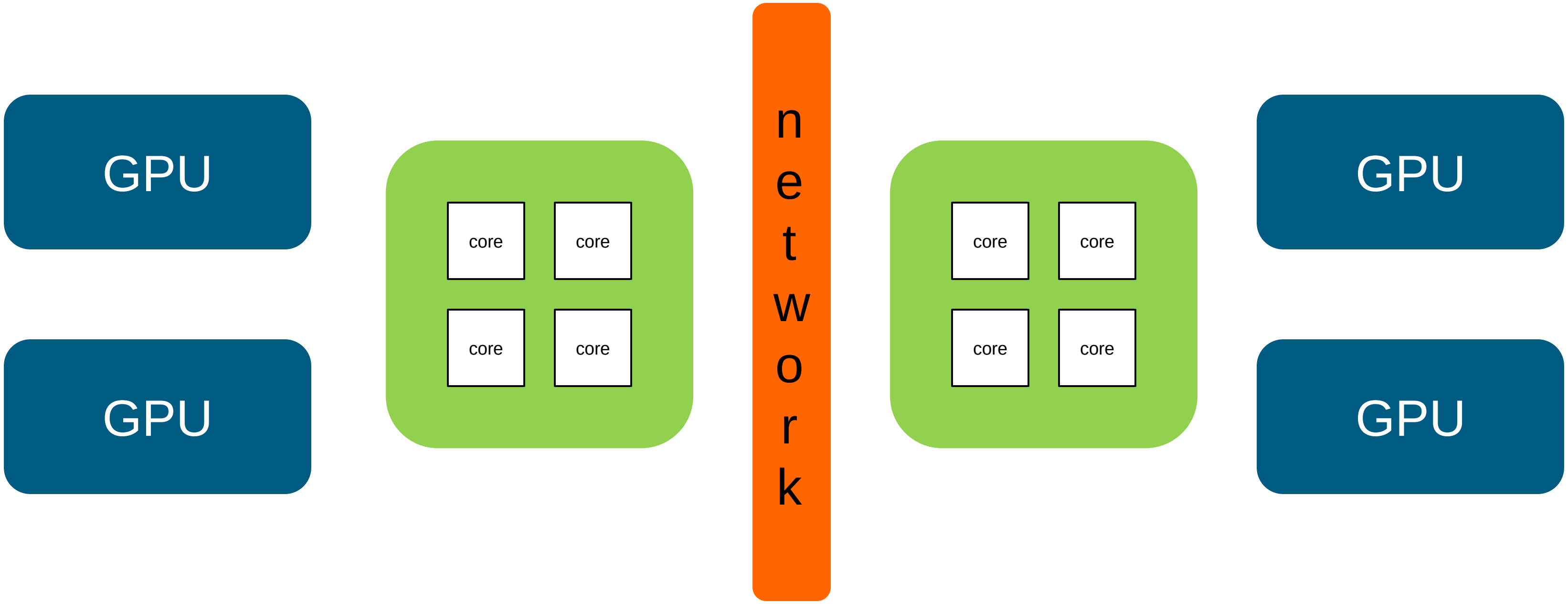
Using Multi GPUs

- Further speedup computations
- Single GPU memory not sufficient
- Increases performance/W

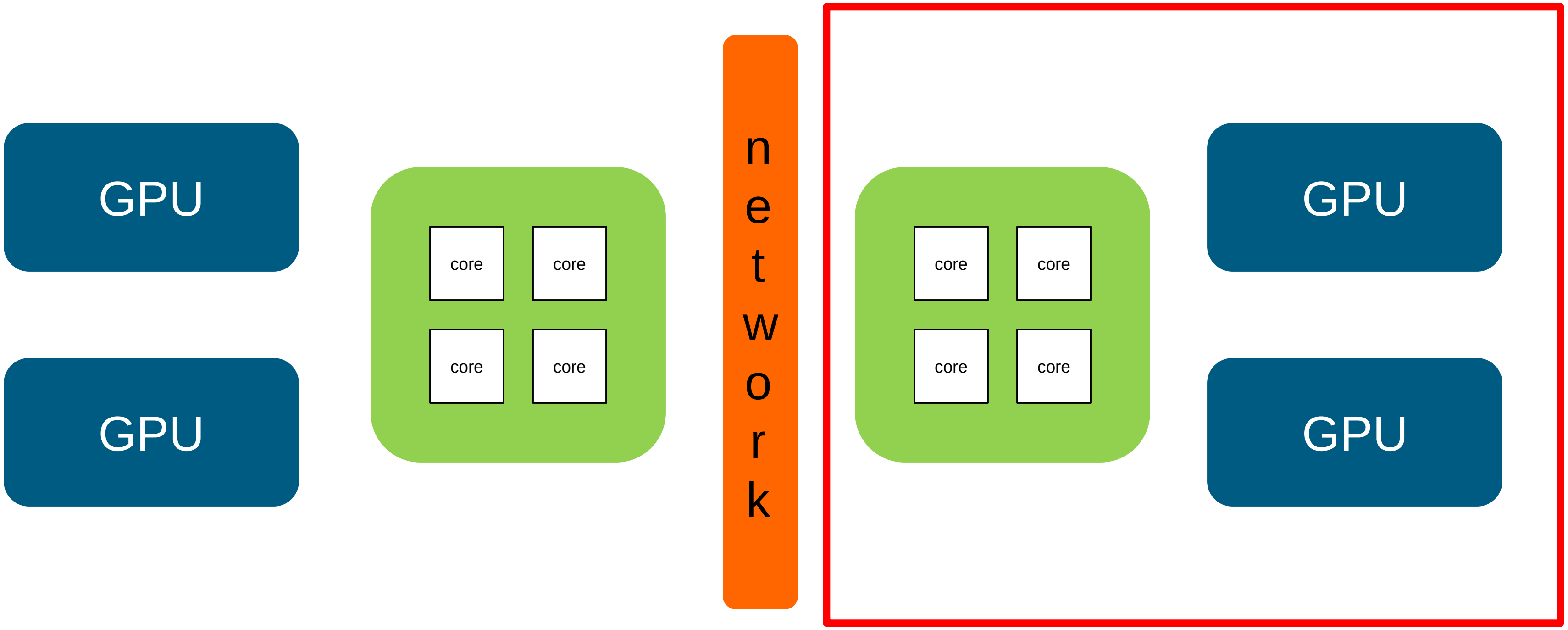
- Intra-node Multi-GPU
  - Easy-to-use, directly use the CUDA API

- Inter-node Multi-GPU
  - Network communication with MPI

Application scenario



Application scenario



Intra-node Multi-GPU

- Single CPU thread access Multiple GPUs
- CUDA calls issued to *current* GPU
- cudaSetDevice(x) sets the current GPU.
- Example

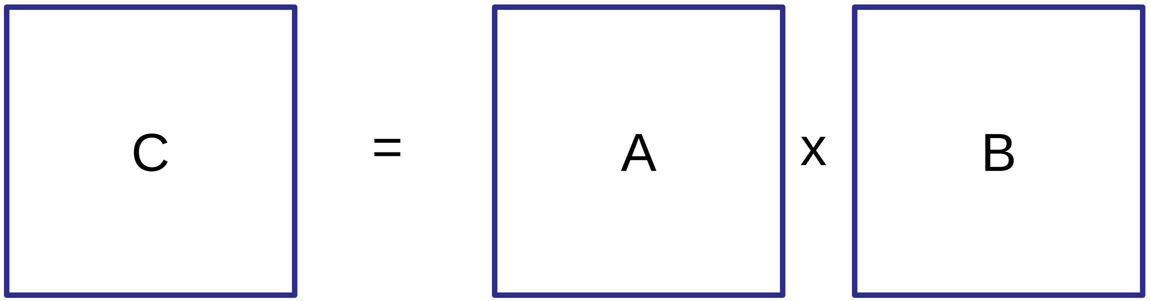
```
cudaSetDevice(0);
cudaMalloc(dst_0,…);
cudaMemcpy(dst_0, …);
cudaSetDevice(1);
cudaMalloc(dst_1,…);
cudaMemcpy(dst_1, …);
```

Intra-node Multi-GPU

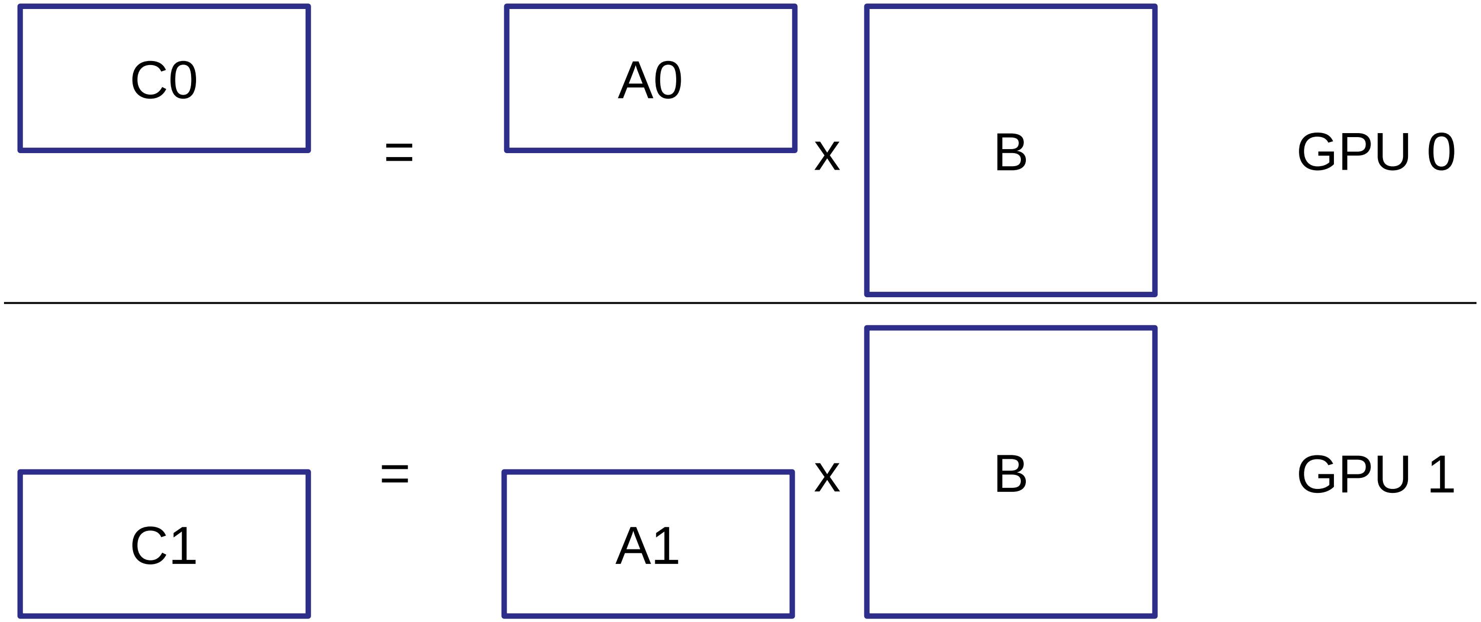
- Current GPU can be changed even when async calls (kernels, async memcopies) are running
- Example

```
cudaSetDevice(0);
kernel<<<…>>>(…);
cudaSetDevice(1);
cudaMemcpyAsync(…);
```

Multi-GPU Matrix Multiplication



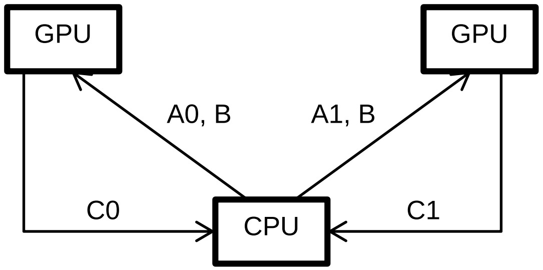
Split A and C into two sets of rows



Exercise: Multi-GPU Matrix Multiplication

- Use Multiple GPUs to speed up Simple Matrix Multiplication
- Split A into 2 set of rows

A0 * B = C0

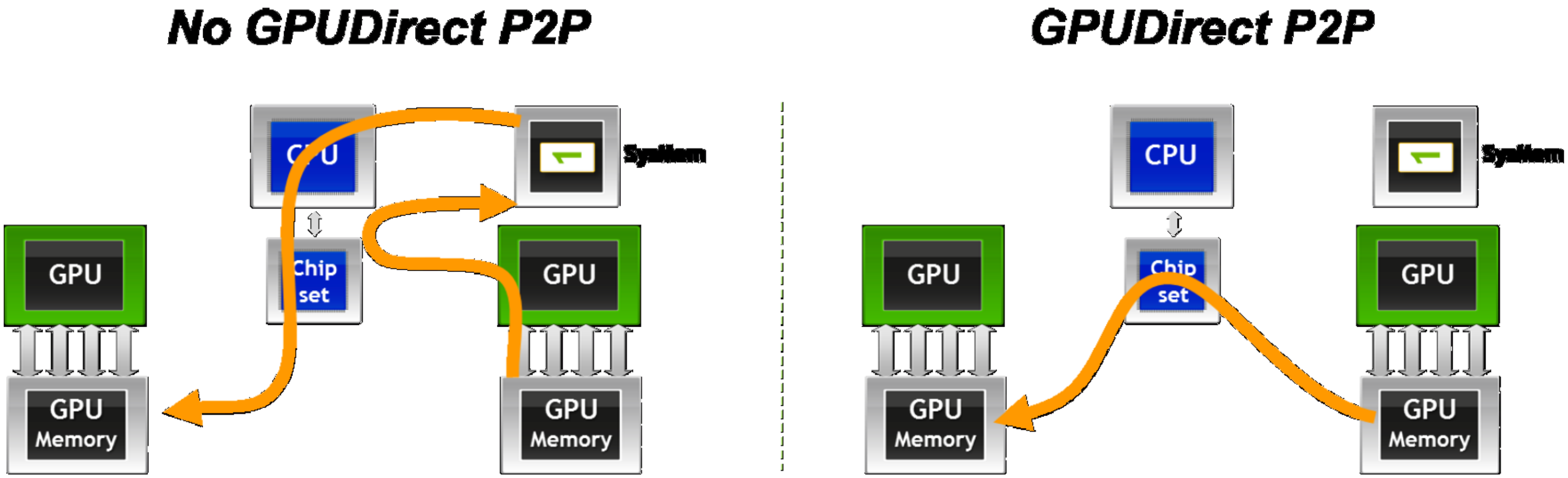


A1 * B = C1

- Verify with NVVP that two GPUs are used.

Intra-node Multi-GPU Communication

- One GPU has to access data from another GPU
- Traditional method: Go about it through the CPU/Main Memory
- Due to UVA: Peer-to-peer memcopies (GPUDirect P2P)



Intra-node Multi-GPU Communication

- Check if the GPU can access Peer device

  ```
  cudaDeviceCanAccessPeer(&accessible, dev_x, dev_y);
  ```

- First enable Peer-to-peer communication

  ```
  cudaDeviceEnablePeerAccess(peer_device,0);
  ```

- Transfer data between two devices

  ```
  cudaMemcpy(dst, src, size, cudaMemcpyDeviceToDevice);
  ```

  - *Also works if peer access is not possible or not enabled (fall back with host memory staging)*

Exercise:

- Compare memcopies between two devices using:
  - Manual staging through main memory
  - Using GPUDirect Peer to Peer