



# GPU Teaching Kit

Accelerated Computing



## Module 4 – Memory and Data Locality

### Lecture 4.2 - Tiled Parallel Algorithms

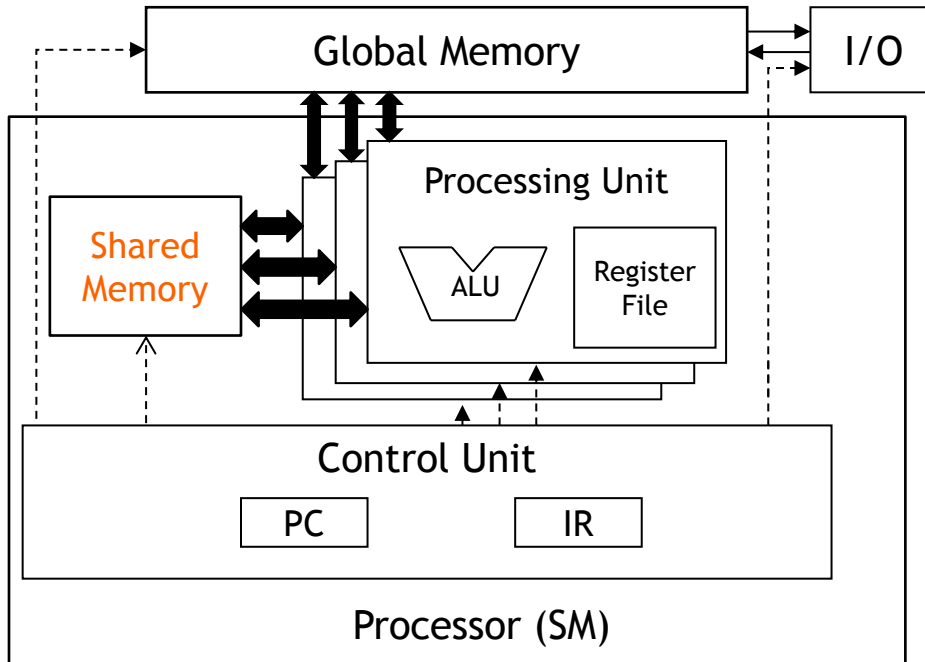


# Objective

- To understand the motivation and ideas for tiled parallel algorithms
  - Reducing the limiting effect of memory bandwidth on parallel kernel performance
  - Tiled algorithms and barrier synchronization



# Hardware View of CUDA Memories



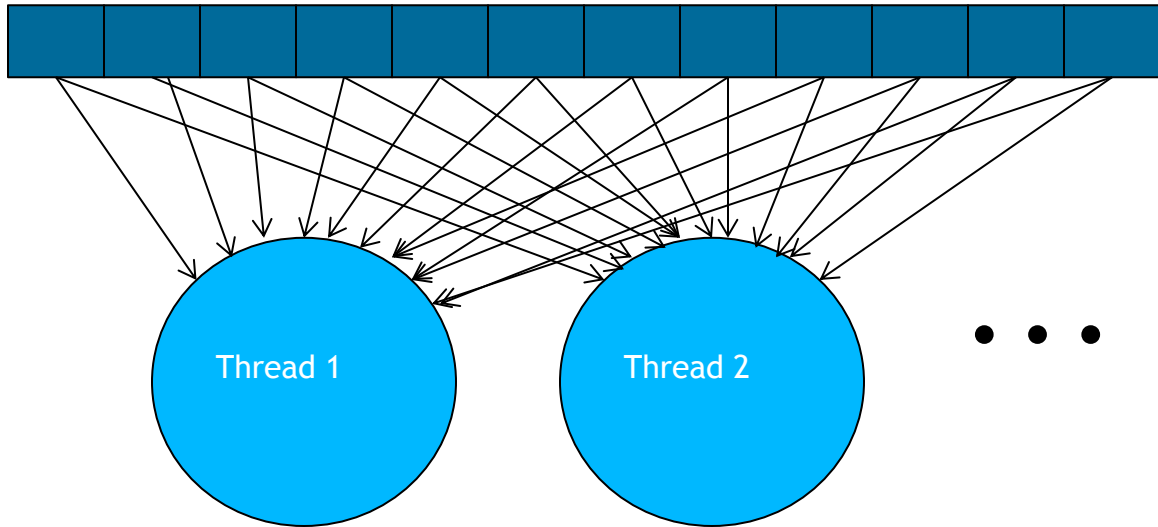
# Basic Concept of Tiling

- In a congested traffic system, significant reduction of vehicles can greatly improve the delay seen by all vehicles
  - Carpooling for commuters
  - Tiling for global memory accesses
    - drivers = threads accessing their memory data operands
    - cars = memory access requests



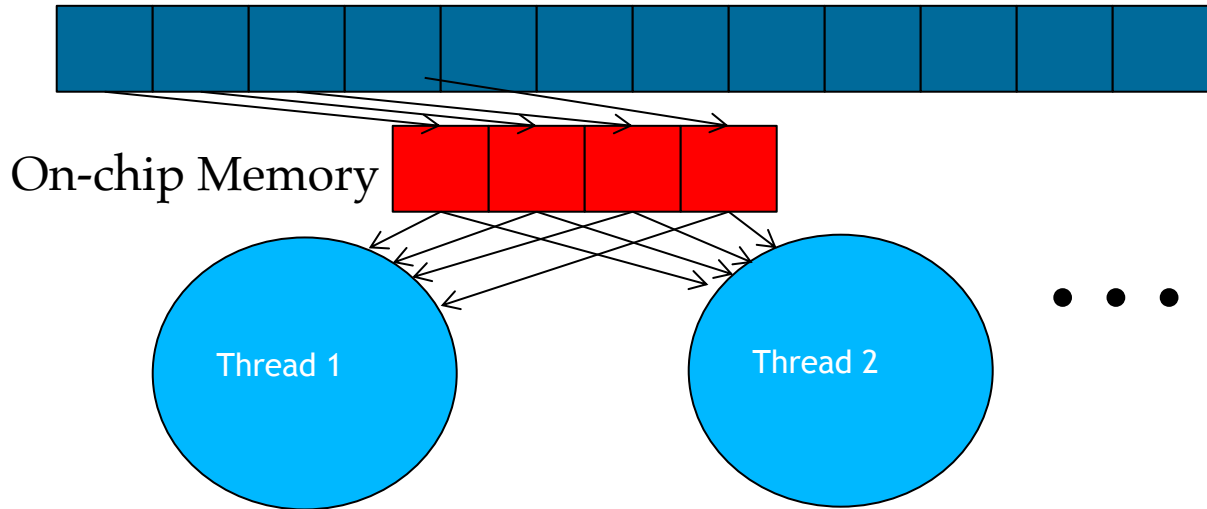
# Global Memory Access Pattern of the Basic Matrix Multiplication Kernel

Global Memory



# Tiling/Blocking - Basic Idea

Global Memory



Divide the global memory content into tiles

Focus the computation of threads on one or a small number of tiles at each point in time

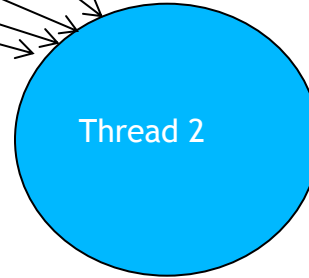
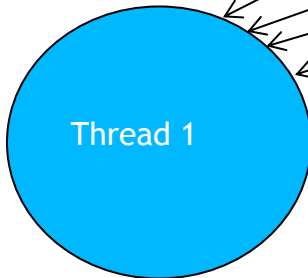


# Tiling/Blocking - Basic Idea

Global Memory



On-chip Memory



...



# Some Computations are More Challenging to Tile

- Some carpools may be easier than others
  - Car pool participants need to have similar work schedule
  - Some vehicles may be more suitable for carpooling
- Similar challenges exist in tiling





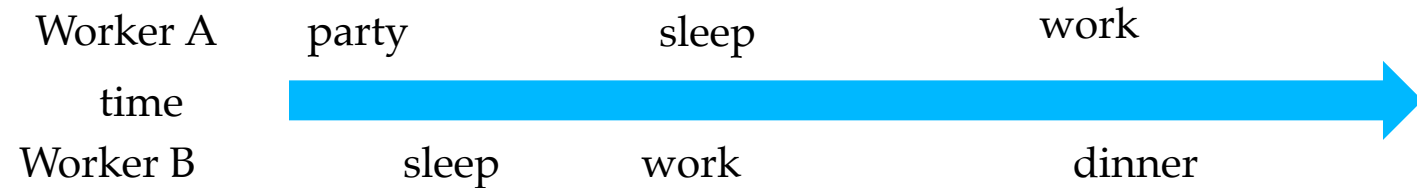
# Carpools need synchronization.

- Good: when people have similar schedule

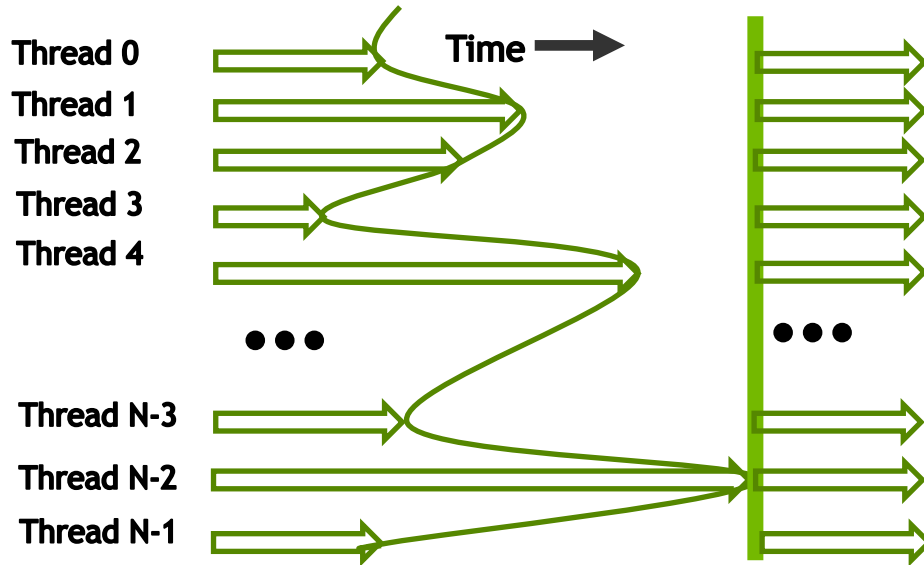


# Carpools need synchronization.

- Bad: when people have very different schedule



# Barrier Synchronization for Tiling



# Using Coalescing for Tiling

- Identify a tile of global memory contents that are accessed by multiple threads
- Load the tile from global memory into on-chip memory
- Use barrier synchronization to make sure that all threads are ready to start the phase
- Have the multiple threads to access their data from the on-chip memory
- Use barrier synchronization to make sure that all threads have completed the current phase
- Move on to the next tile



# Using Coalescing for Tiling

