PARALLEL MULTIPLE OBSERVER SITING ON TERRAIN

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OBJECTIVES

- **Optimization of the multiple observer siting program of Franklin and Vogt**
- **Parallelization using OpenMP and Nvidia CUDA**

MULTIPLE OBSERVER SITING

- Four programs running in sequence
  1. *VIX* computes approximate visibility indexes
  2. *FINDMAX* selects a set of tentative observers
  3. *VIEWSHED* computes observer viewsheds
 4. *SITE* selects observers to cover the terrain

$$VIX \rightarrow FINDMAX \rightarrow VIEWSHED \rightarrow SITE$$
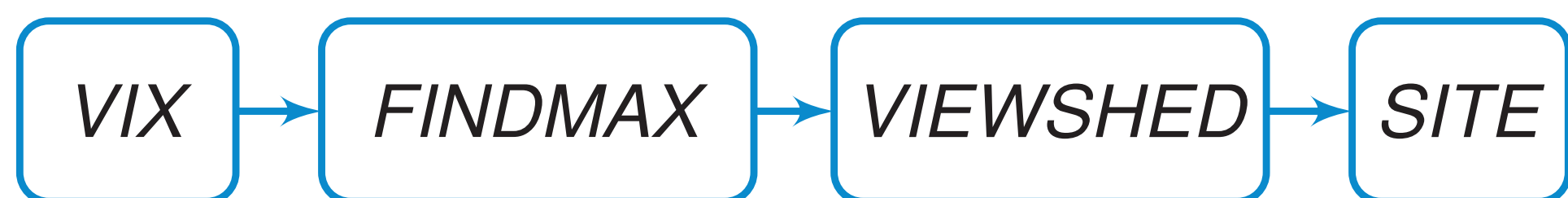
IMPROVEMENTS

- In *VIX*, compute an approximate visibility of a random target by evaluating points with stepsize $stride$
- In each iteration of *SITE*, select the observer whose viewshed has the largest extra area
- Update the extra area of tentative observers within $2 \times roi$ of the selected observer
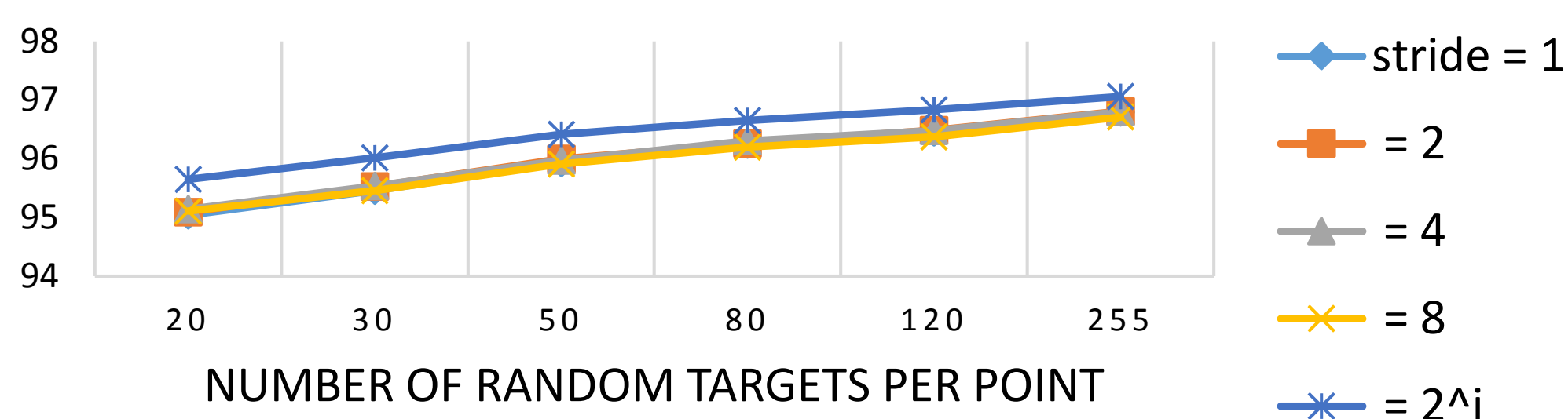
APPROXIMATE VISIBILITY INDEX

- Run the CUDA program on a 16385^2 terrain until the area of the cumulative viewshed cannot be increased
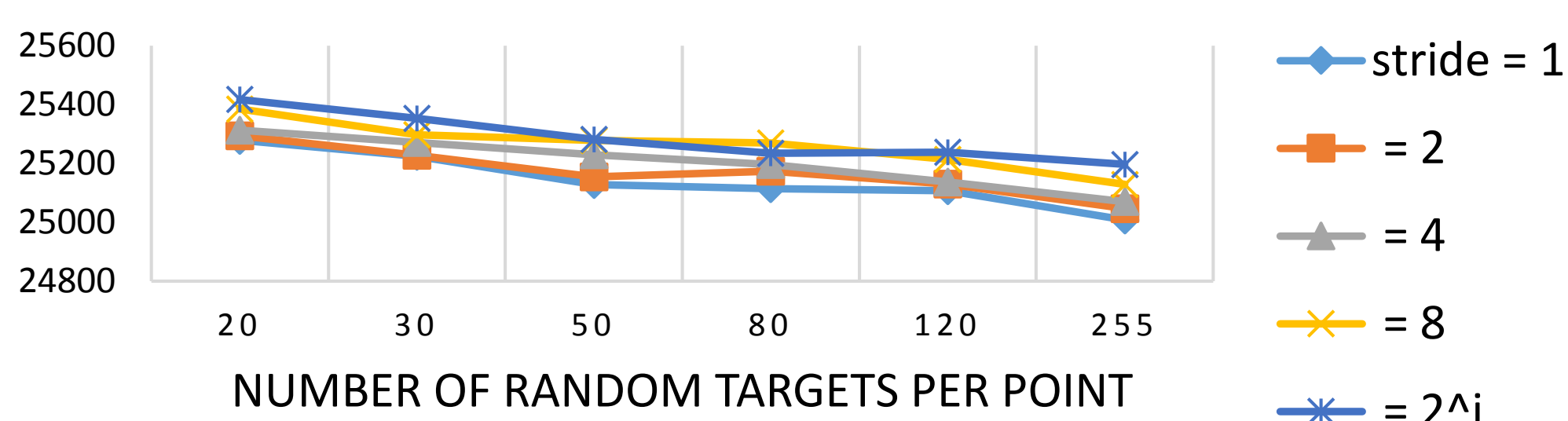- roi is 200 and number of tentative observers is 164^2

RUNNING TIME OF CUDA VIX

NUMBER OF RANDOM TARGETS PER POINT

- stride = 1
- = 2
- = 4
- = 8
- = 2^i
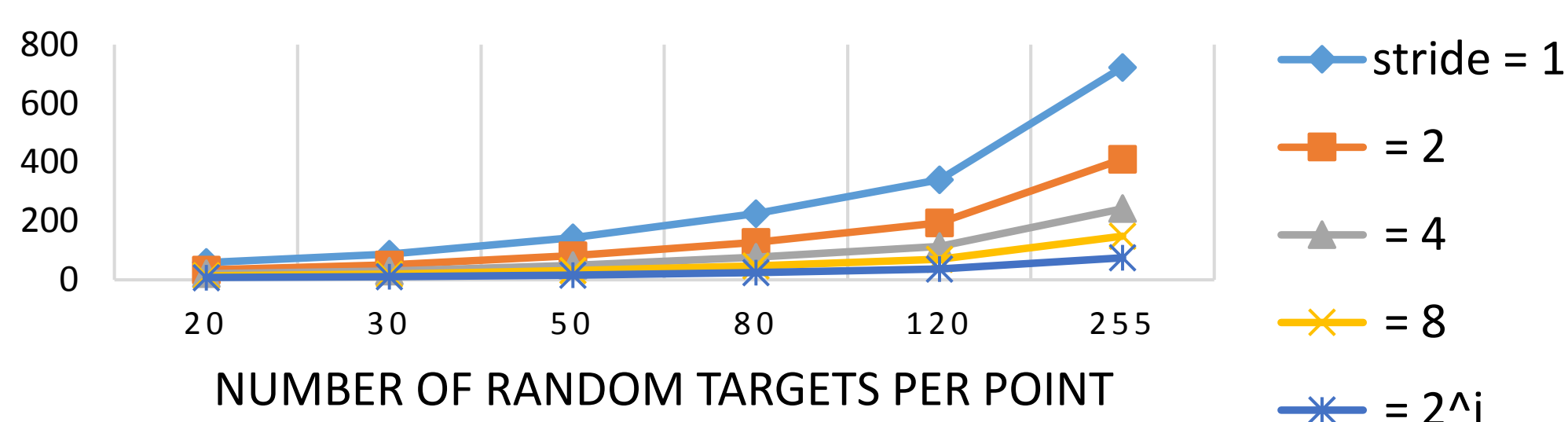
MAXIMUM COVERAGE (%)

NUMBER OF RANDOM TARGETS PER POINT

- stride = 1
- = 2
- = 4
- = 8
- = 2^i

NUMBER OF SELECTED OBSERVERS

NUMBER OF RANDOM TARGETS PER POINT

- stride = 1
- = 2
- = 4
- = 8
- = 2^i

CUDA PROGRAM

- Seven kernel functions
  1. Compute visibility indexes
  2. Select tentative observers
  3. Compute viewsheds
  4. Search observers for update
  5. Compute the extra area of an observer
  6. Search observers for the largest extra area
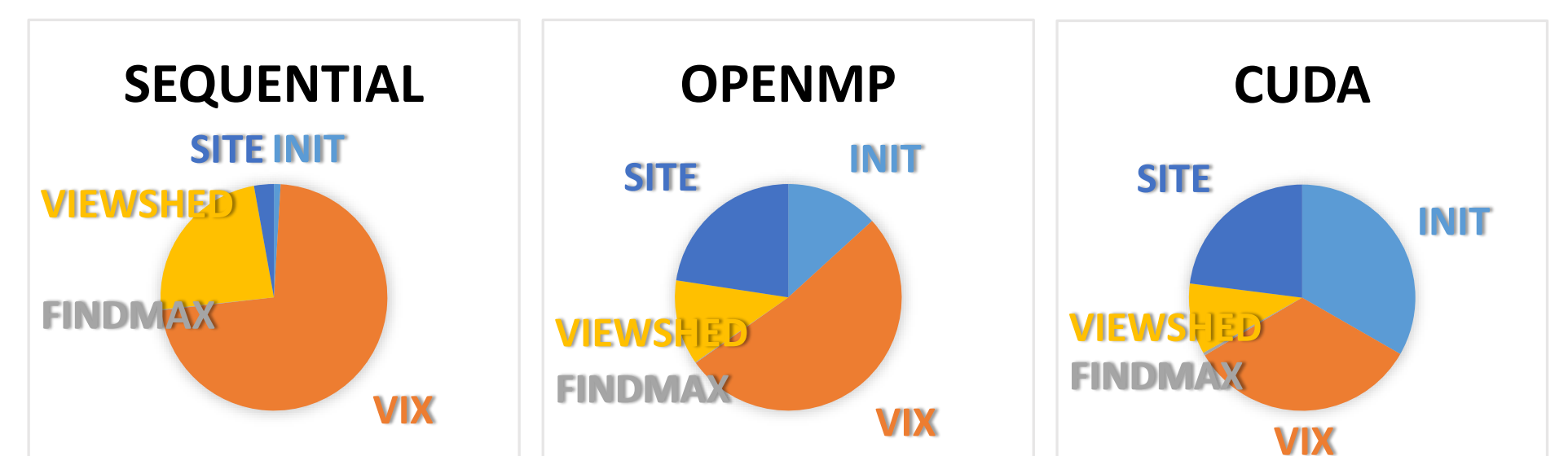 7. Update the cumulative viewshed

$$1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 6 \rightarrow 7$$
$$5$$
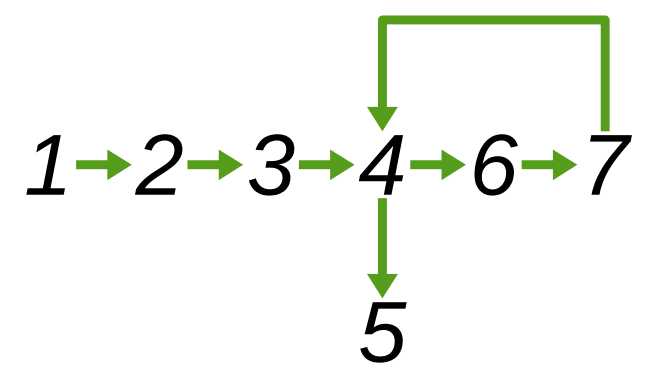
RUNNING TIME & SPEEDUP

- Two Intel Xeon E5-2687W CPUs and one Nvidia Tesla K20Xm GPU accelerator
- Different resolutions of a 16385^2 terrain; number of random targets is 30 and number of tentative observers is $10^2, 20^2, 41^2, 82^2,$ or 164^2
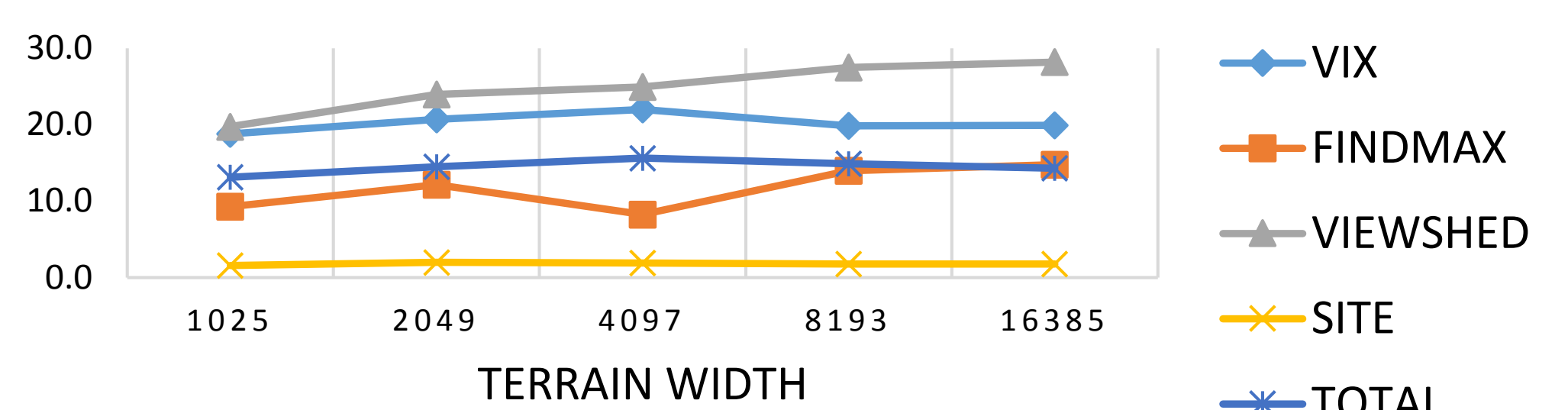
TOTAL RUNNING TIME

TERRAIN WIDTH

- Sequential
- OpenMP
- CUDA
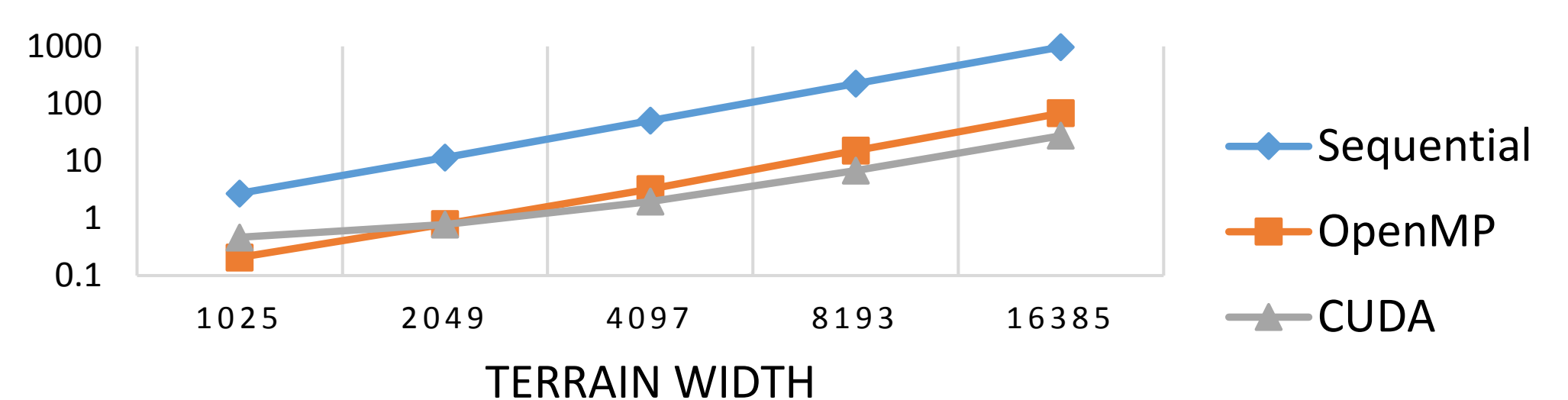
- Composition of the total time at terrain width 16385

SEQUENTIAL — OPENMP — CUDA

- Speedup to the sequential program

OPENMP PROGRAM SPEEDUP

TERRAIN WIDTH

- VIX
- FINDMAX
- VIEWSHED
- SITE
- TOTAL

CUDA PROGRAM SPEEDUP

TERRAIN WIDTH

- VIX
- FINDMAX
- VIEWSHED
- SITE
- TOTAL

ACKNOWLEDGEMENT