ECE 563
Programming Parallel Machines

Parallelized Graphics Rendering Using Software Implementation Of OpenGLES

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OpenGLES

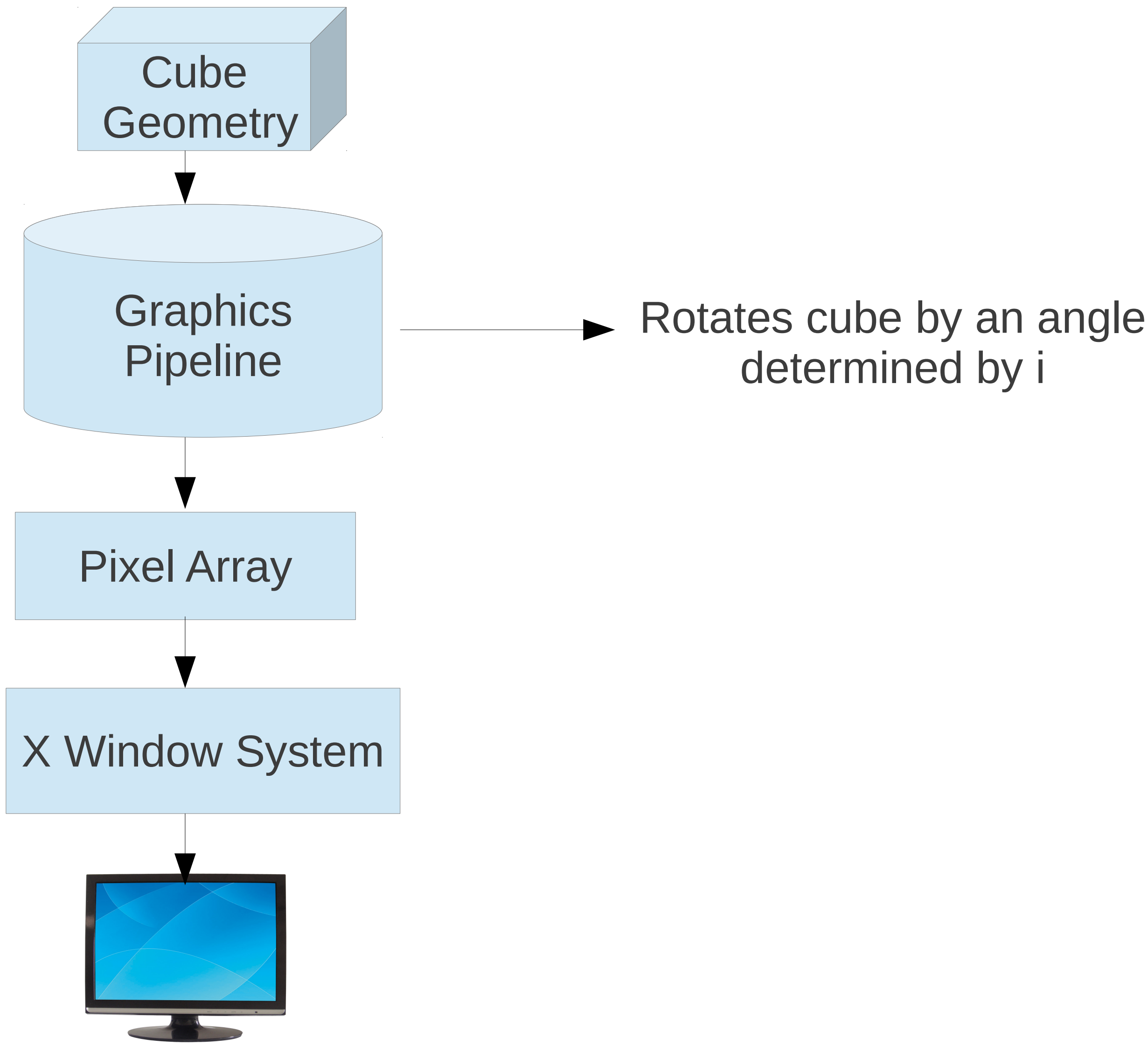
- **Open G**raphics **L**ibrary for **E**mbedded **S**ystems
  - API for rendering graphics in mobile devices
- Often interacts with GPU for accelerated graphics rendering

Objective

- Parallelize the graphics rendering of a test application using software implementation of OpenGLES (implemented in C++)
- Useful for accelerated graphics rendering in the absence of hardware accelerators like GPU

Sequential Code Control Flow

```
for( i =0; i < N; i++)
{
```




```
}
```

Parallelization Methodologies

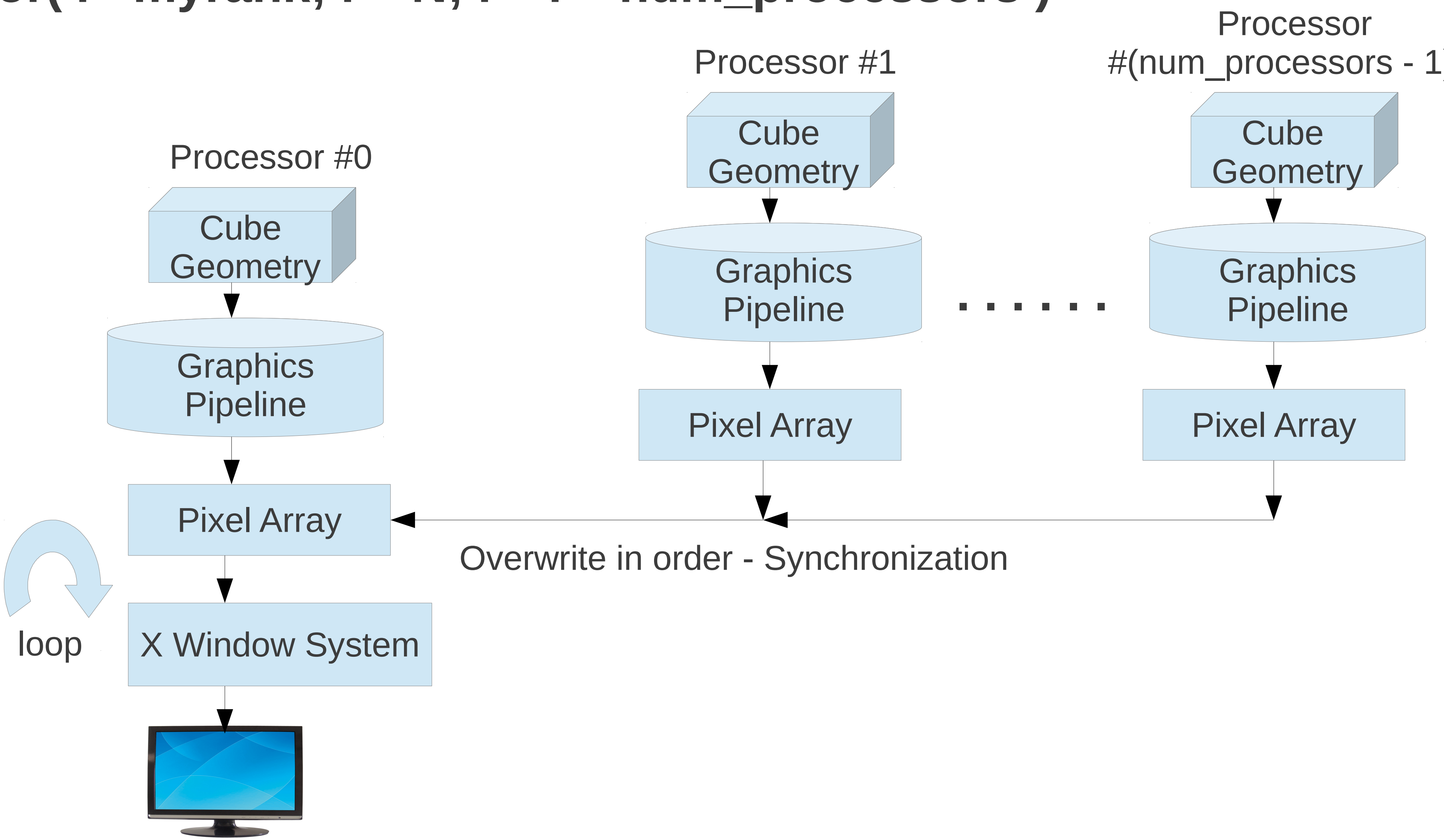
1. Rotation Parallelization using MPI

2. Cube Face Rendering Parallelization Using OpenMP

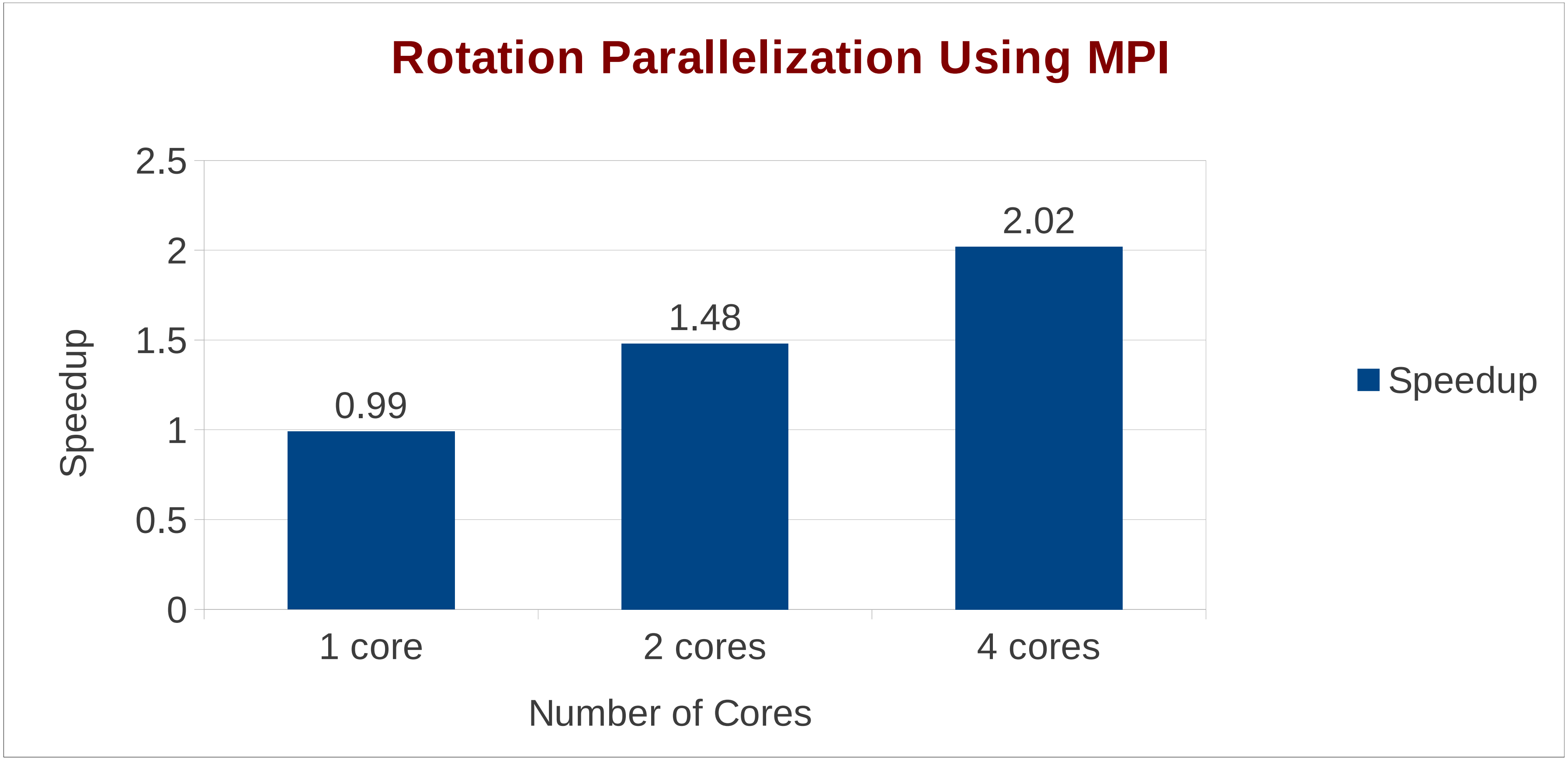
3. Rasterization Parallelization using MPI

Rotation Parallelization using MPI

for(i =myrank; i < N; i = i + num_processors)
{



}



Description	Percentage
Sequential	0.8%
Parallel	99.2%
Synchronization	33.1% of the parallel section

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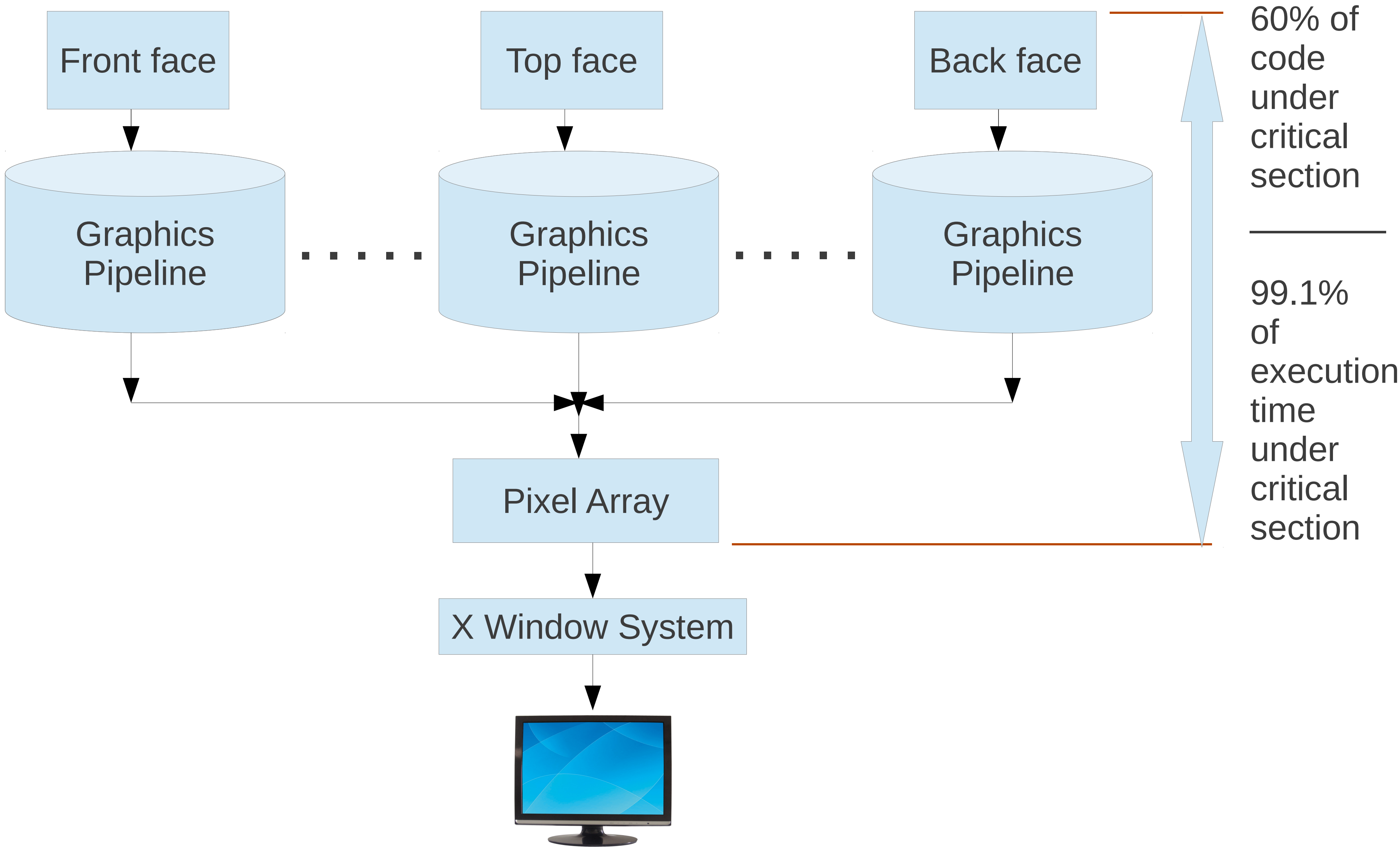
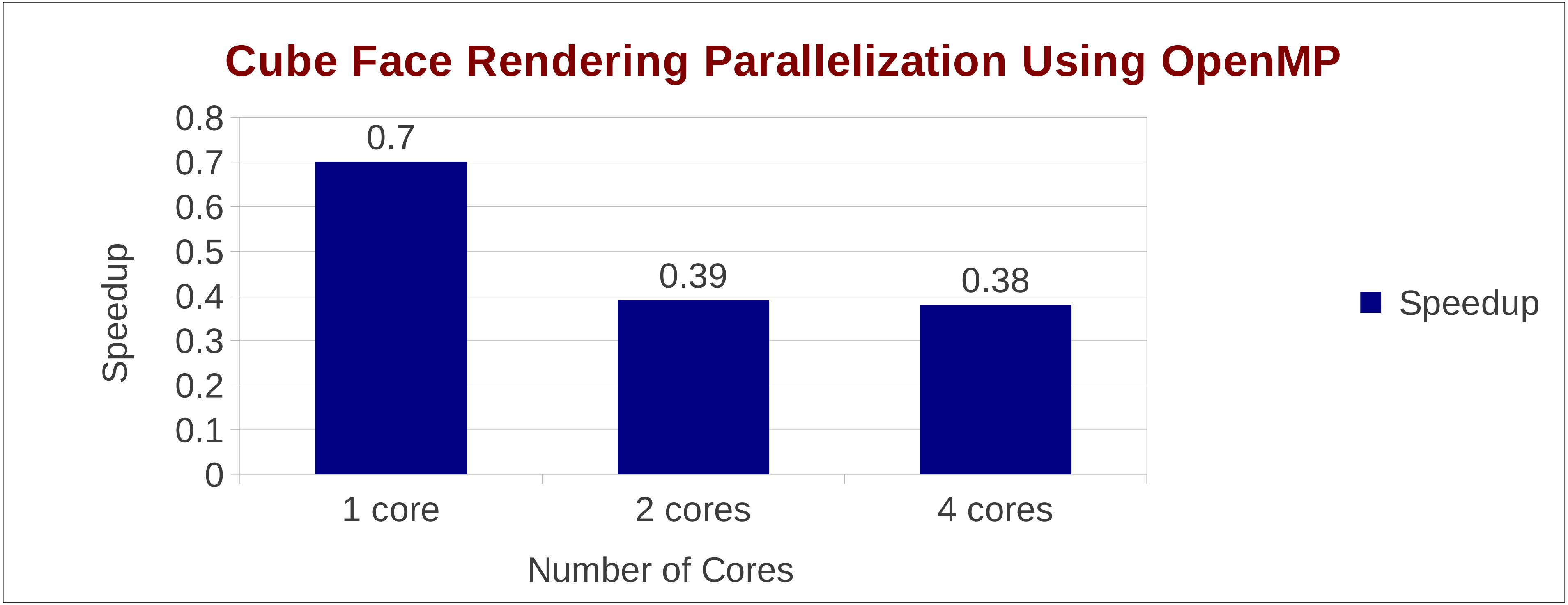
Cube Face Rendering Parallelization using OpenMP

#pragma omp section // Rewrote the matrix operations
// to handle privatized matrices per face

{



}



Description	Time in microseconds
Critical Section in Parallelized Code with 1 core	21110
Same Section in original Sequential Code	9965

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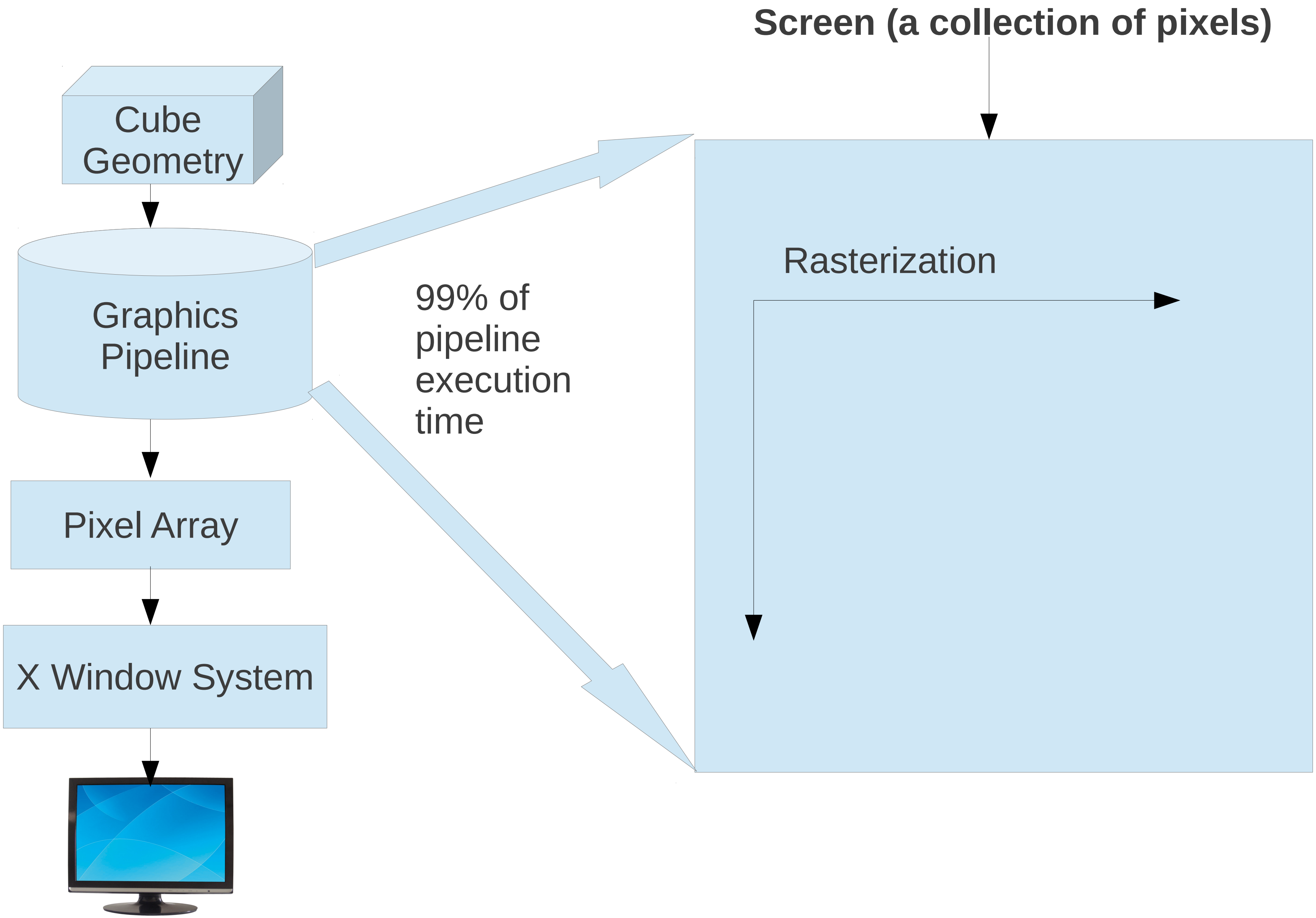
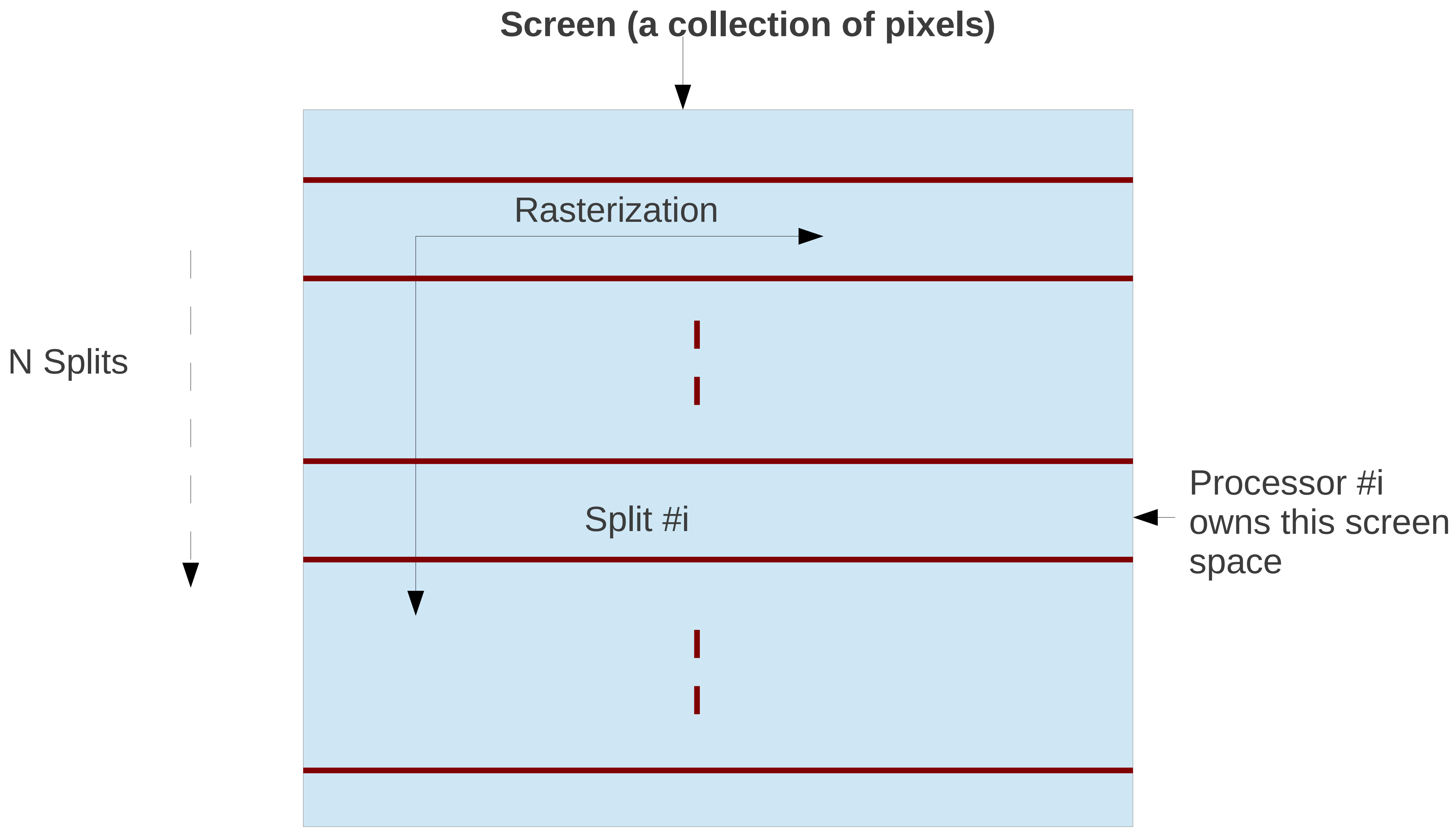
Rasterization Parallelization

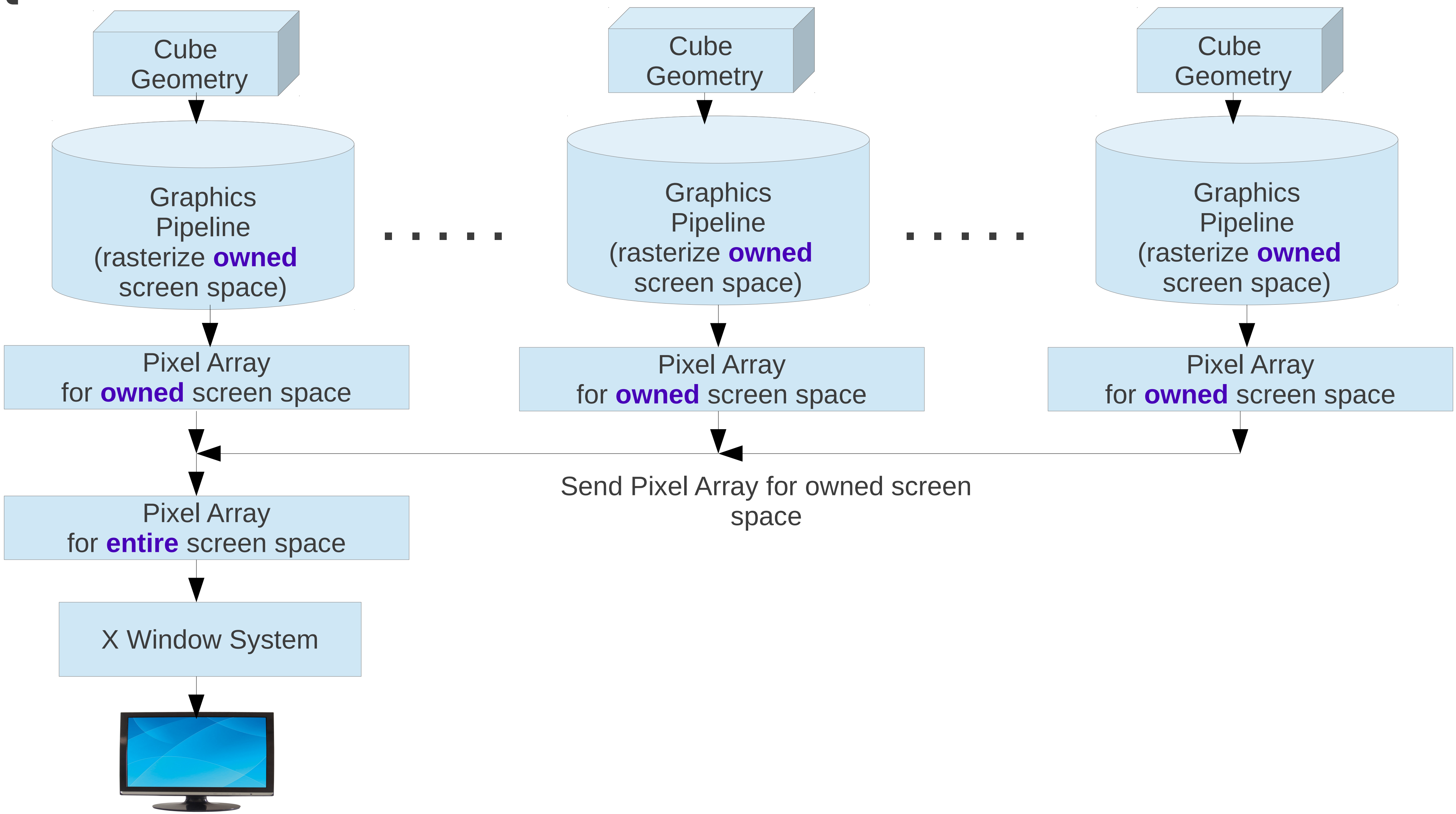


Rasterization Parallelization using MPI

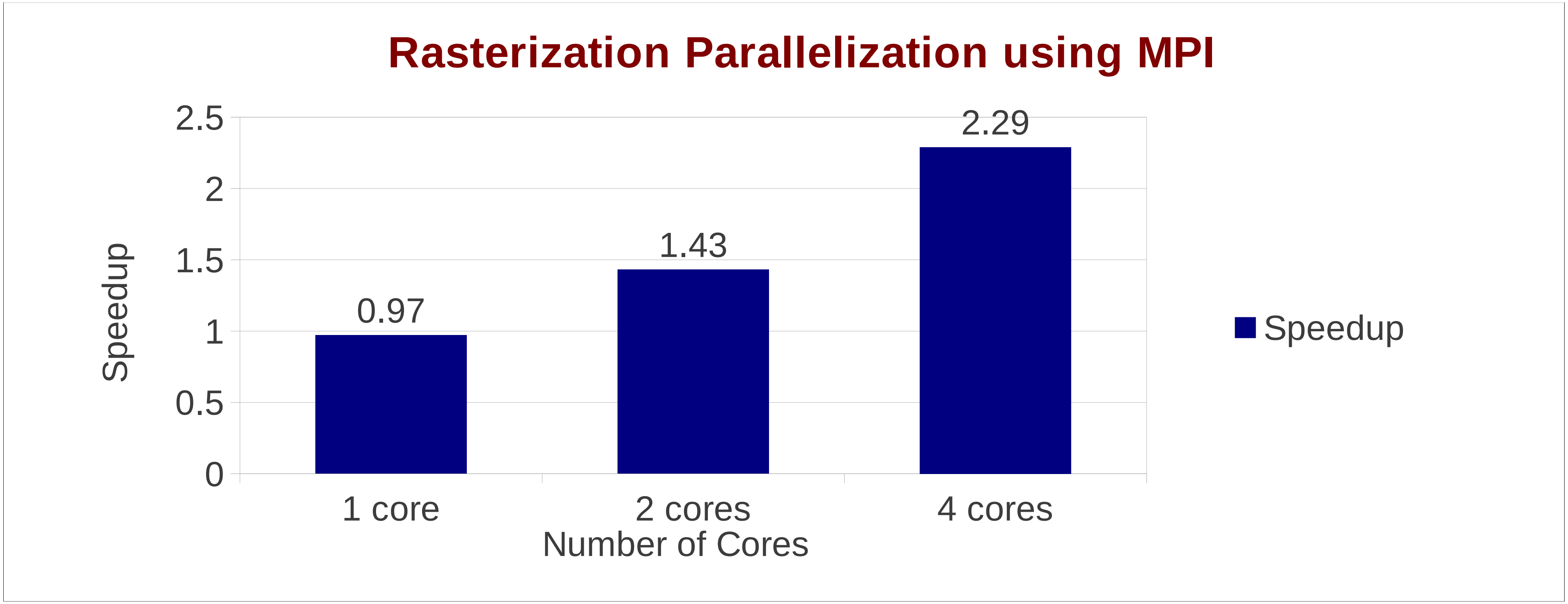


Rasterization Parallelization using MPI

```
for( i =0; i < N; i++)  //10 Induction Variables Substituted
{
```

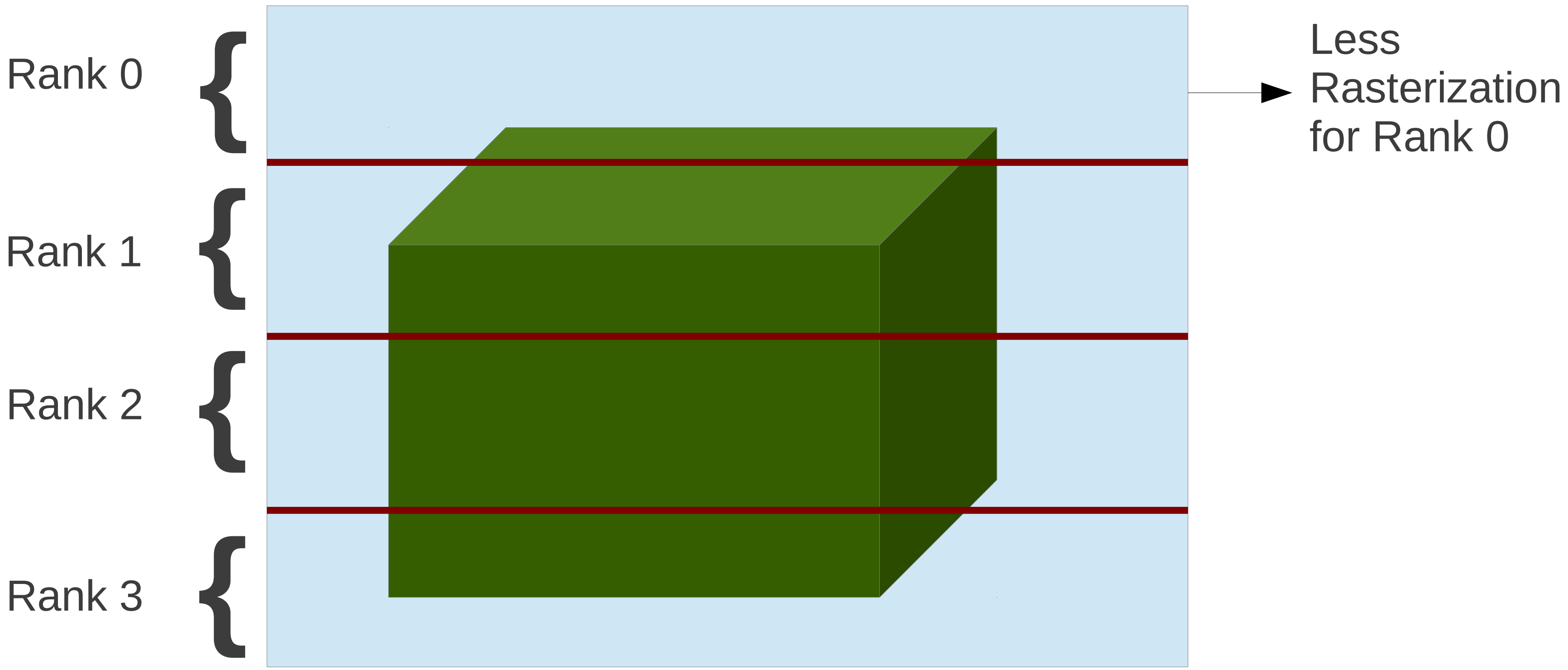



```
}
```

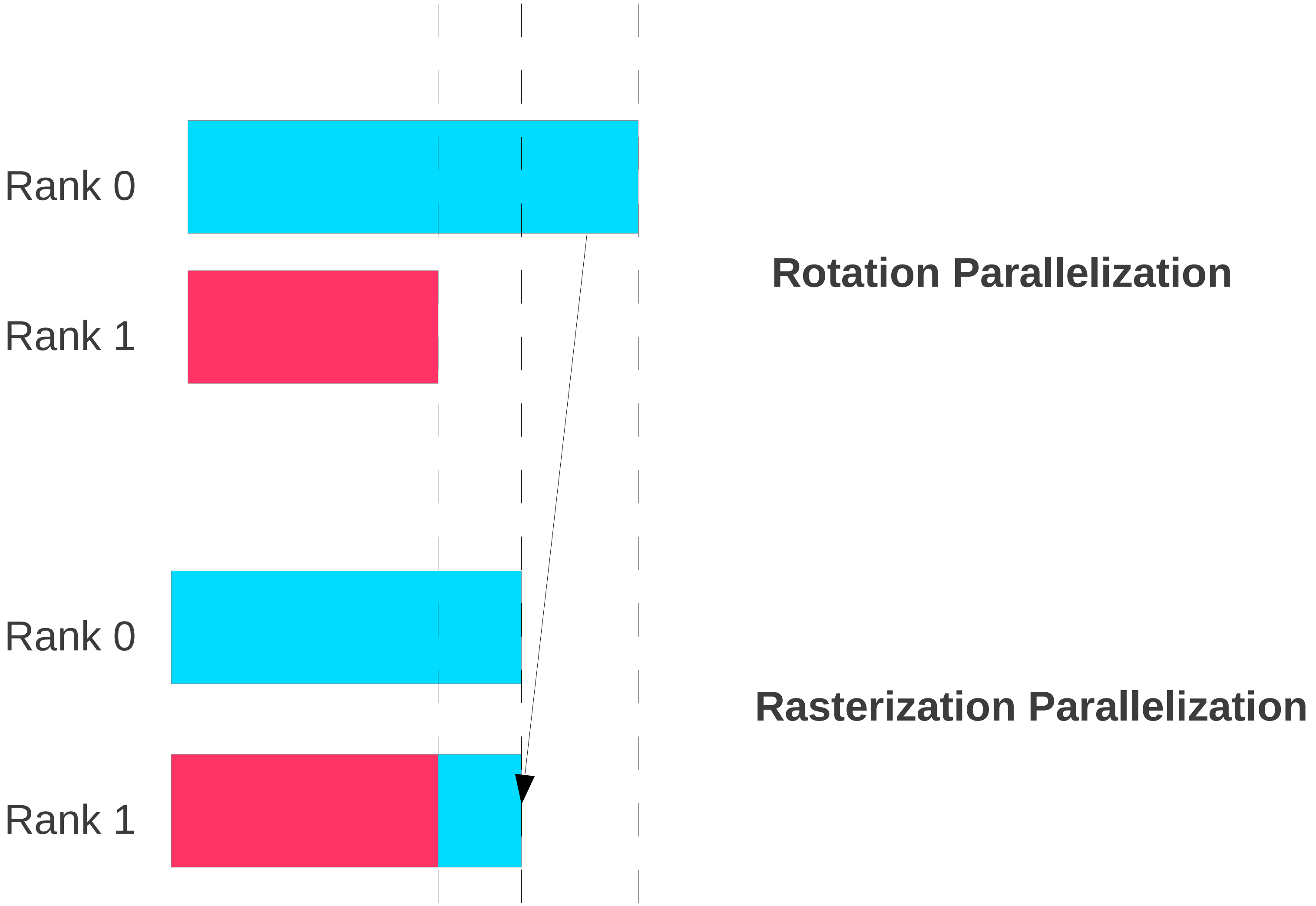

Rasterization Parallelization using MPI
Speedup
Number of Cores
1 core
2 cores
4 cores
0
0.5
1
1.5
2
2.5
0.97
1.43
2.29
Speedup

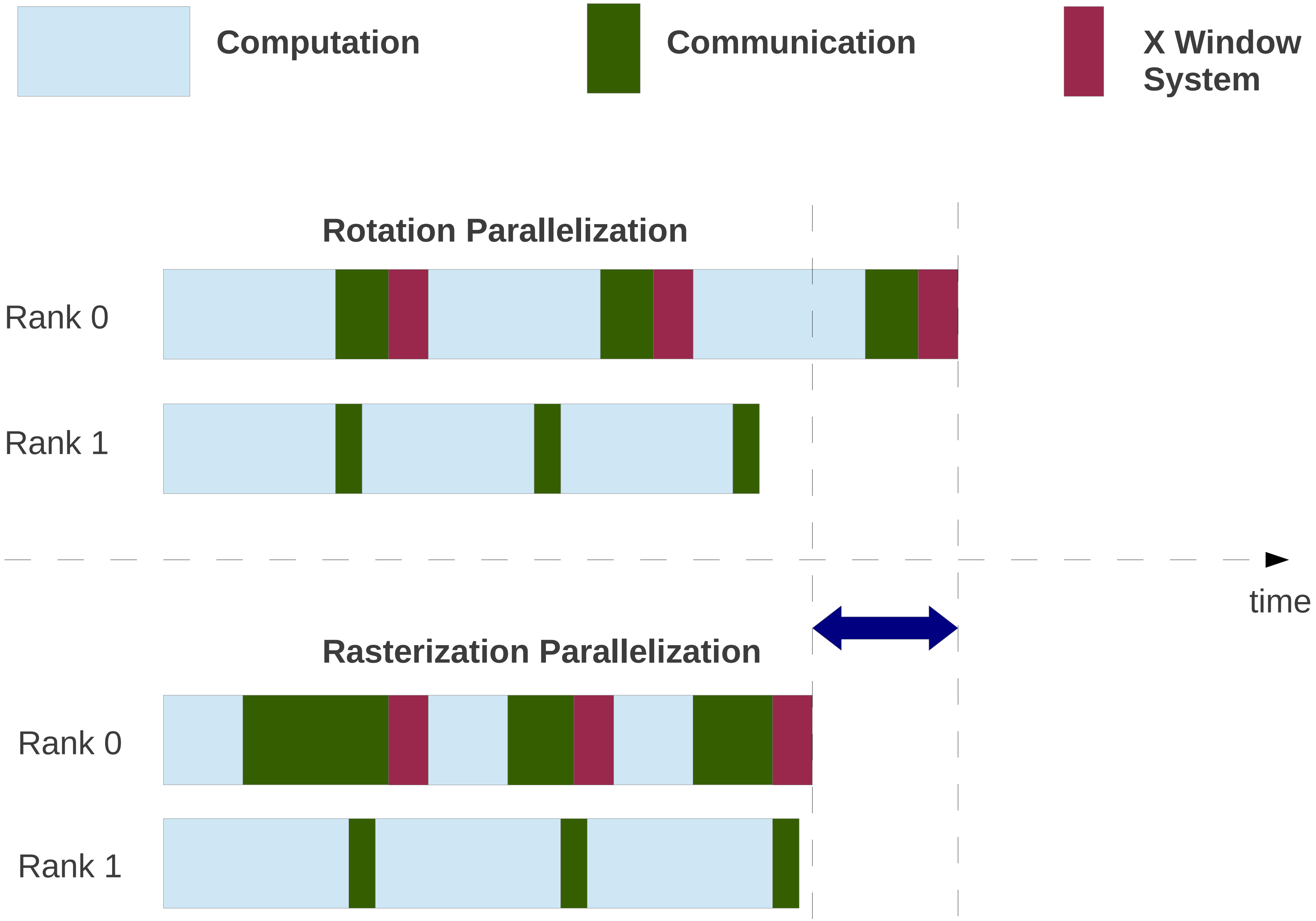
Rotation Parallelization
vs
Rasterization Parallelization

- For 4 cores :
  - Rotation Parallelization Speedup (2.02) < Rasterization Parallelization Speedup(2.29)
- Counter intuitive
  - Rotation Parallelization has more parallel execution than Rasterization Parallelization



Work Offloading




Computation
Communication
X Window System
Rotation Parallelization
Rank 0
Rank 1
time
Rasterization Parallelization
Rank 0
Rank 1

Extra Slides

Induction Variable Substitution Schemes

- Sequential

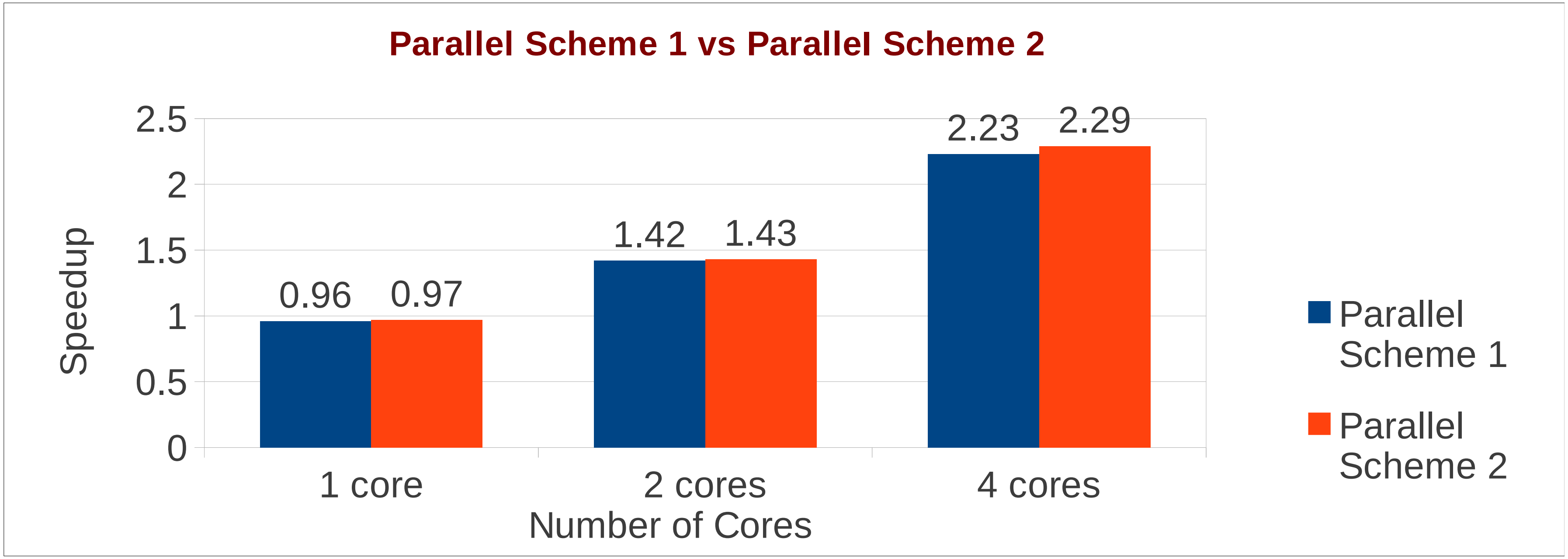
```
k = 0;
for(i = 1; i< N; i++)
    k = k + 2
```

- Parallel Scheme 1

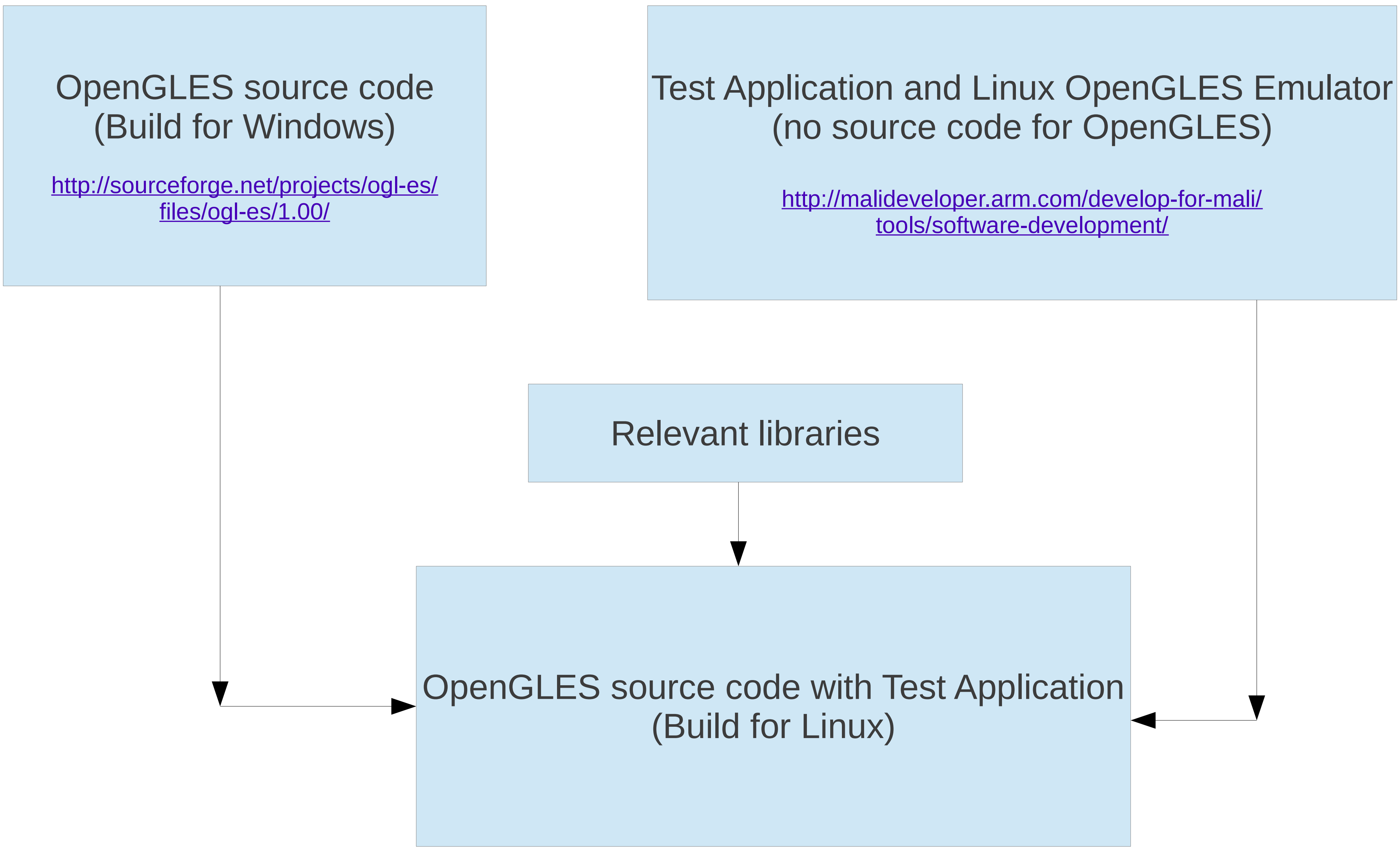
```
for(.....)
    k = i*2;
```

- Parallel Scheme 2

```
k = myrank * chunk_size*2
for(.....)
    k = k +2;
```



Linux Build Creation



Future Work

- Parallelize Rasterization using OpenMP
  - will help eliminate critical section in Cube Face Rendering Parallelization
- Split only the Rasterized screen space evenly among processors using MPI
  - requires OpenGL programming knowledge
- Analyze the parallel engine using more complex test applications
  - Speedup is likely to increase

References

- http://en.wikipedia.org/wiki/OpenGL
- http://en.wikipedia.org/wiki/OpenGL_ES
- http://en.wikipedia.org/wiki/X_Window_System
- http://en.wikipedia.org/wiki/Rasterisation