GPU-based Ray Tracing of Dynamic Scenes

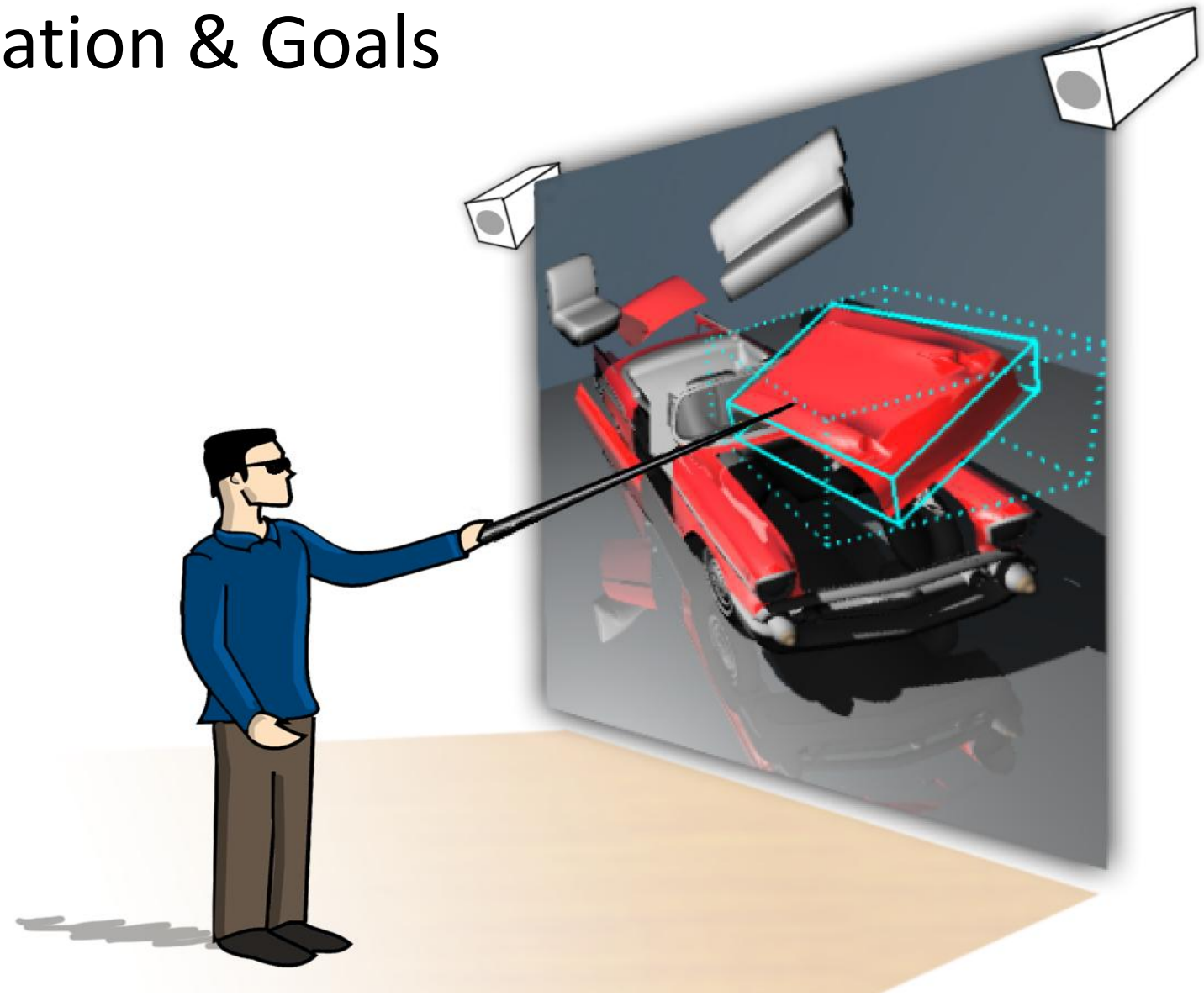
Workshop VR/AR 2008, Magdeburg

Martin Reichl · Robert Dünger · Alexander Schiewe · Markus Hartleb
Thomas Klemmer · Christopher Lux · Bernd Fröhlich

26th of September, 2008

Bauhaus-Universität Weimar · Fakultät Medien
Systeme der Virtuellen Realität

Motivation & Goals



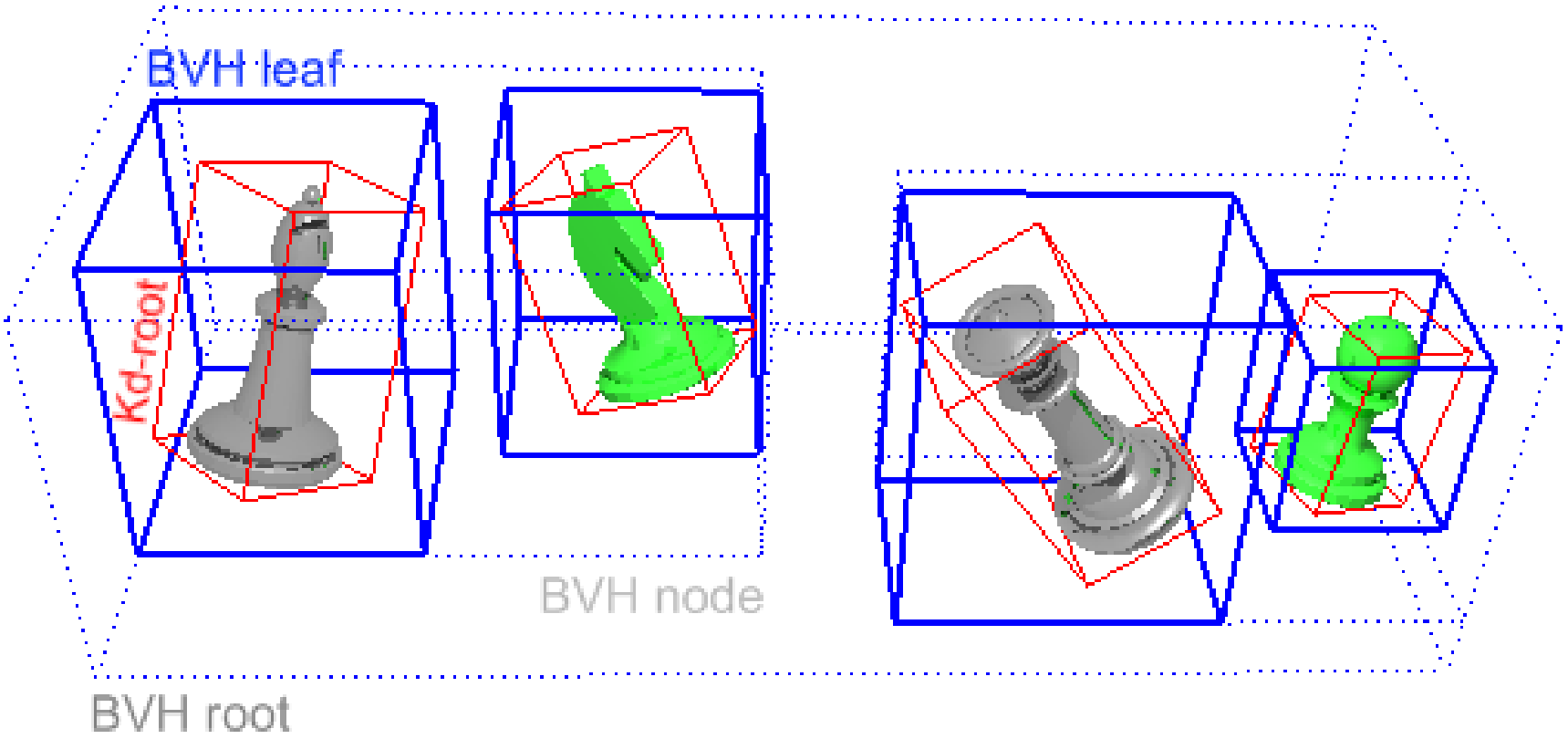
Related Work

		Chip	Data Structures	Stack
Static Scenes	Horn et. al. 2007	GPU	Kd	Short Stack
	Günther et. al. 2007	GPU	BVH	Shared Stack
Dynamic Scenes	OpenRT 2002	CPU	Kd + Kd	Full Stack

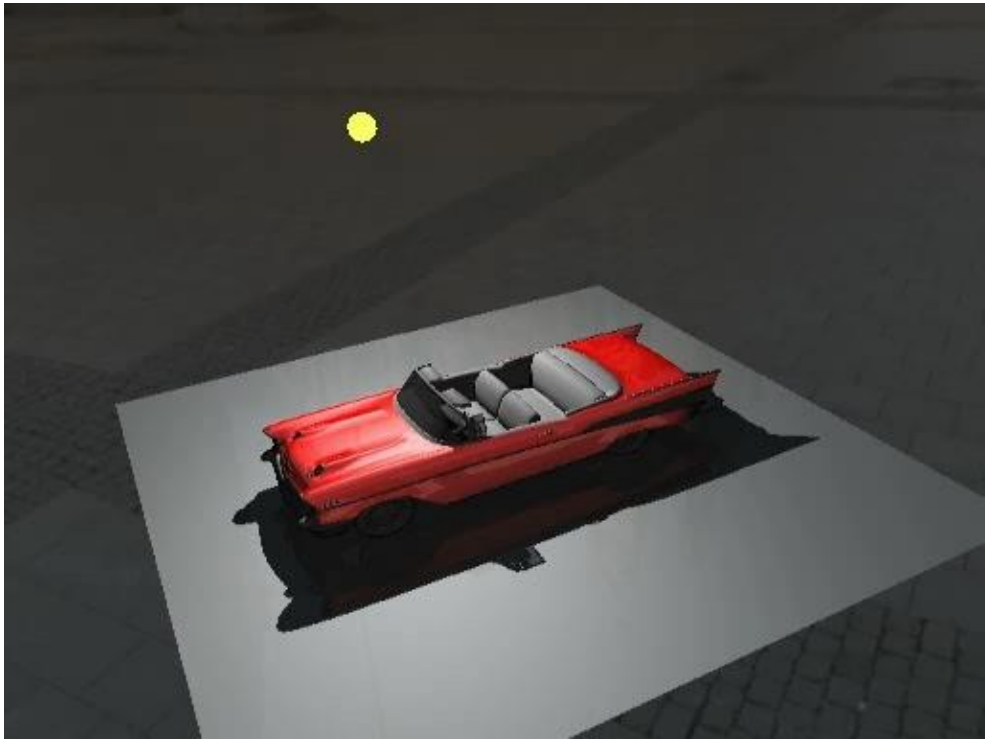
Related Work

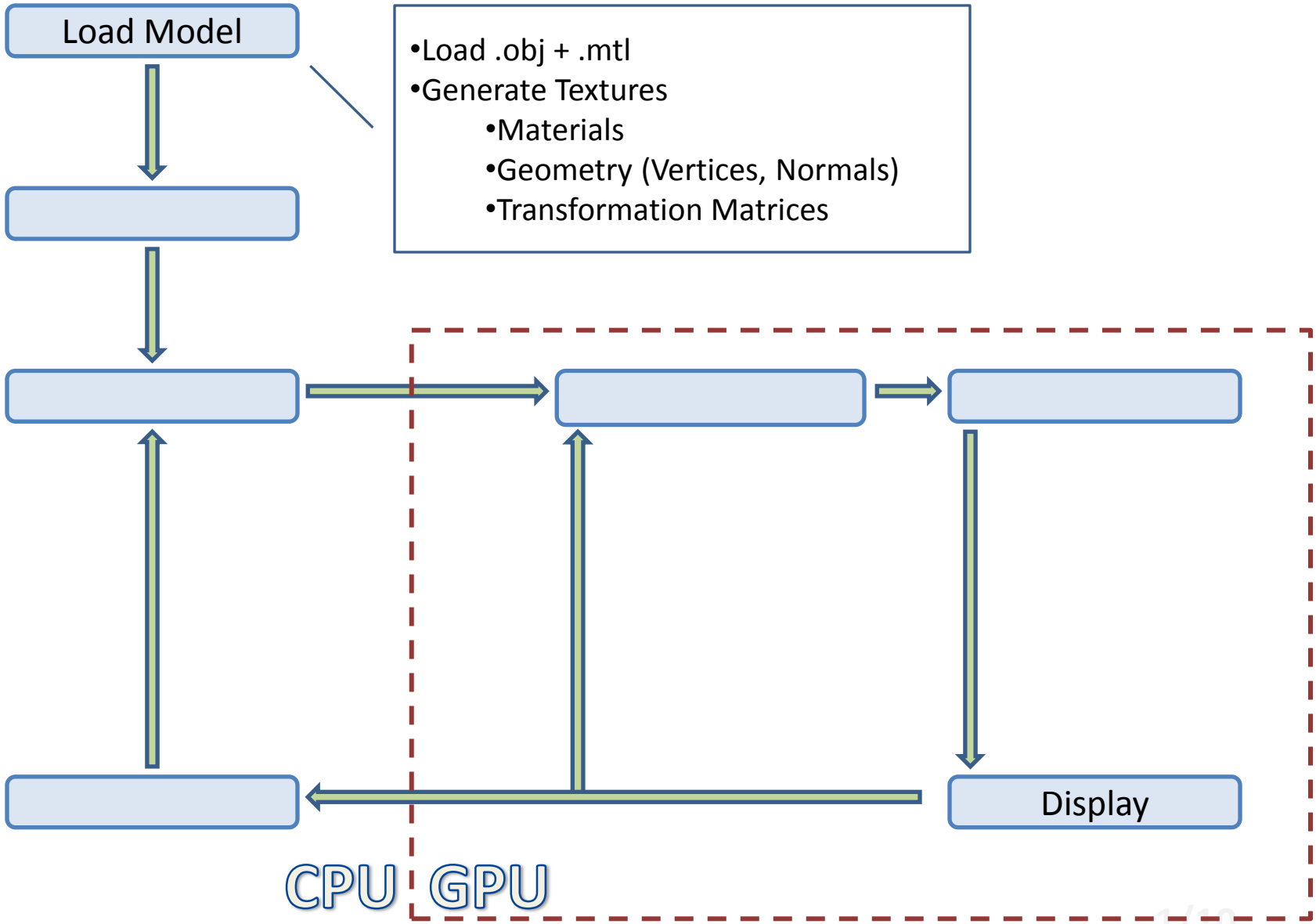
		Chip	Data Structures	Stack
Static Scenes	Horn et. al. 2007	GPU	Kd	Short Stack
	Günther et. al. 2007	GPU	BVH	Shared Stack
Dynamic Scenes	OpenRT 2002	CPU	Kd + Kd	Full Stack
	This work	GPU	BVH + Kd	Smart Stack

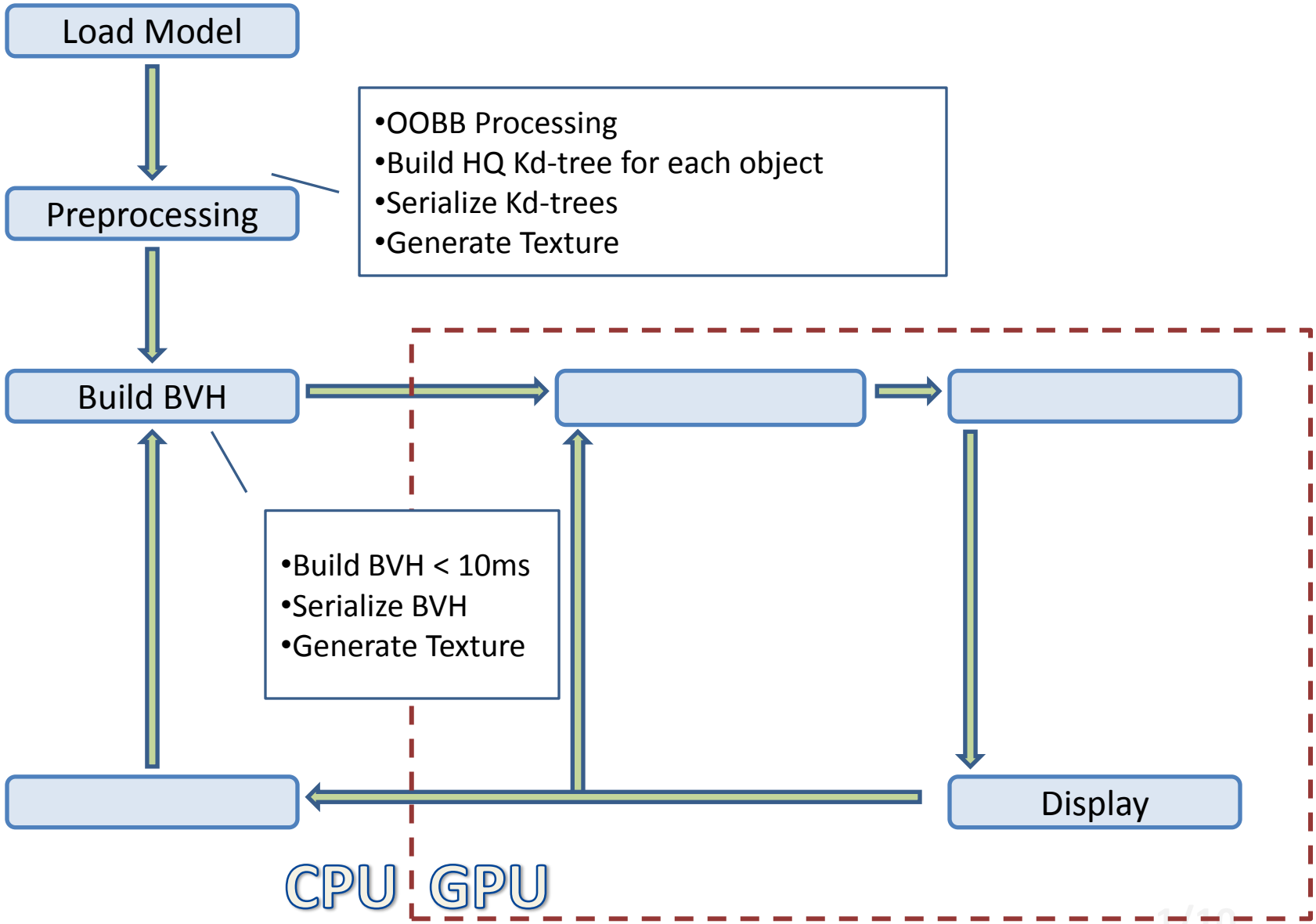
Approach – Two Level Hierarchy

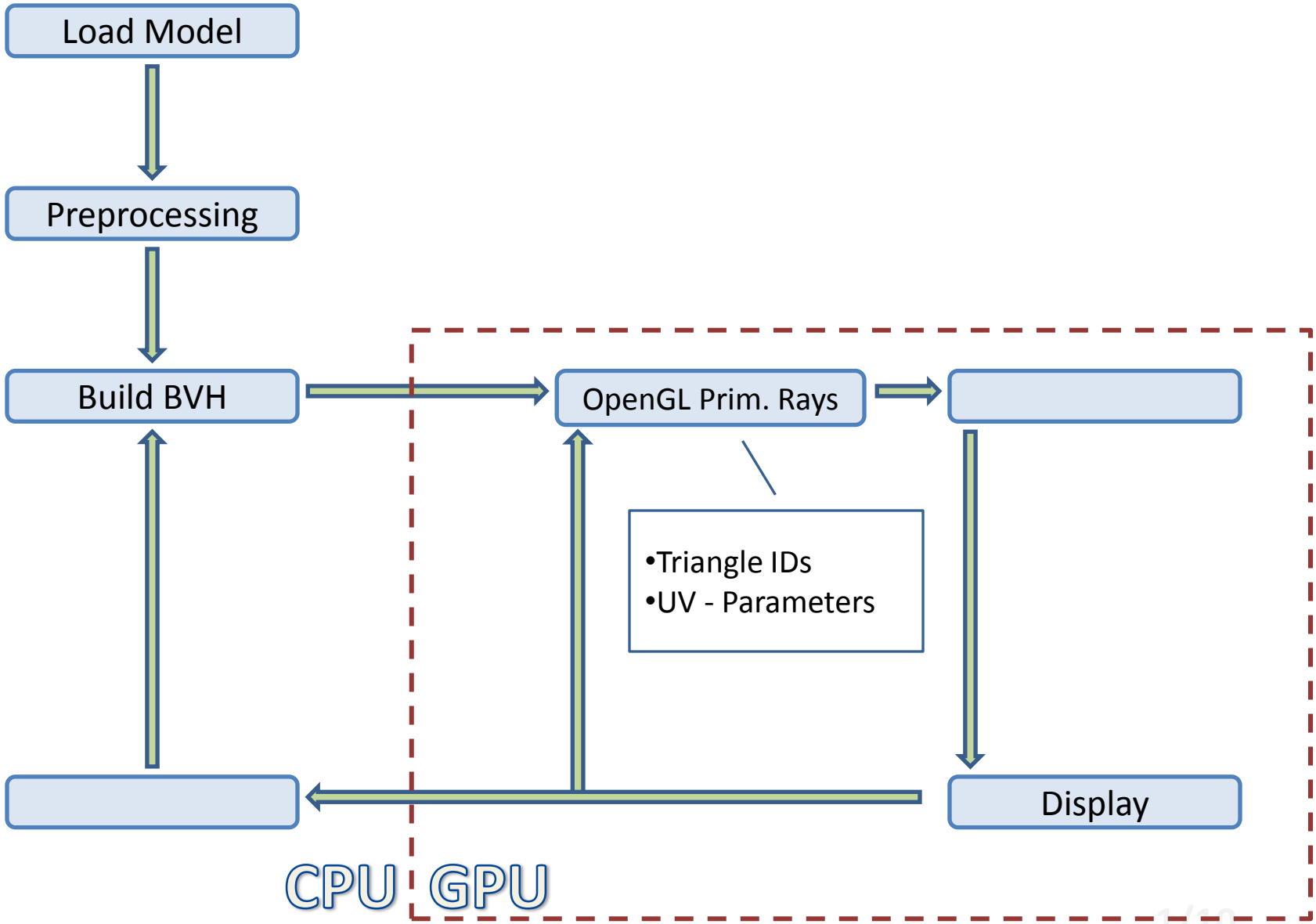


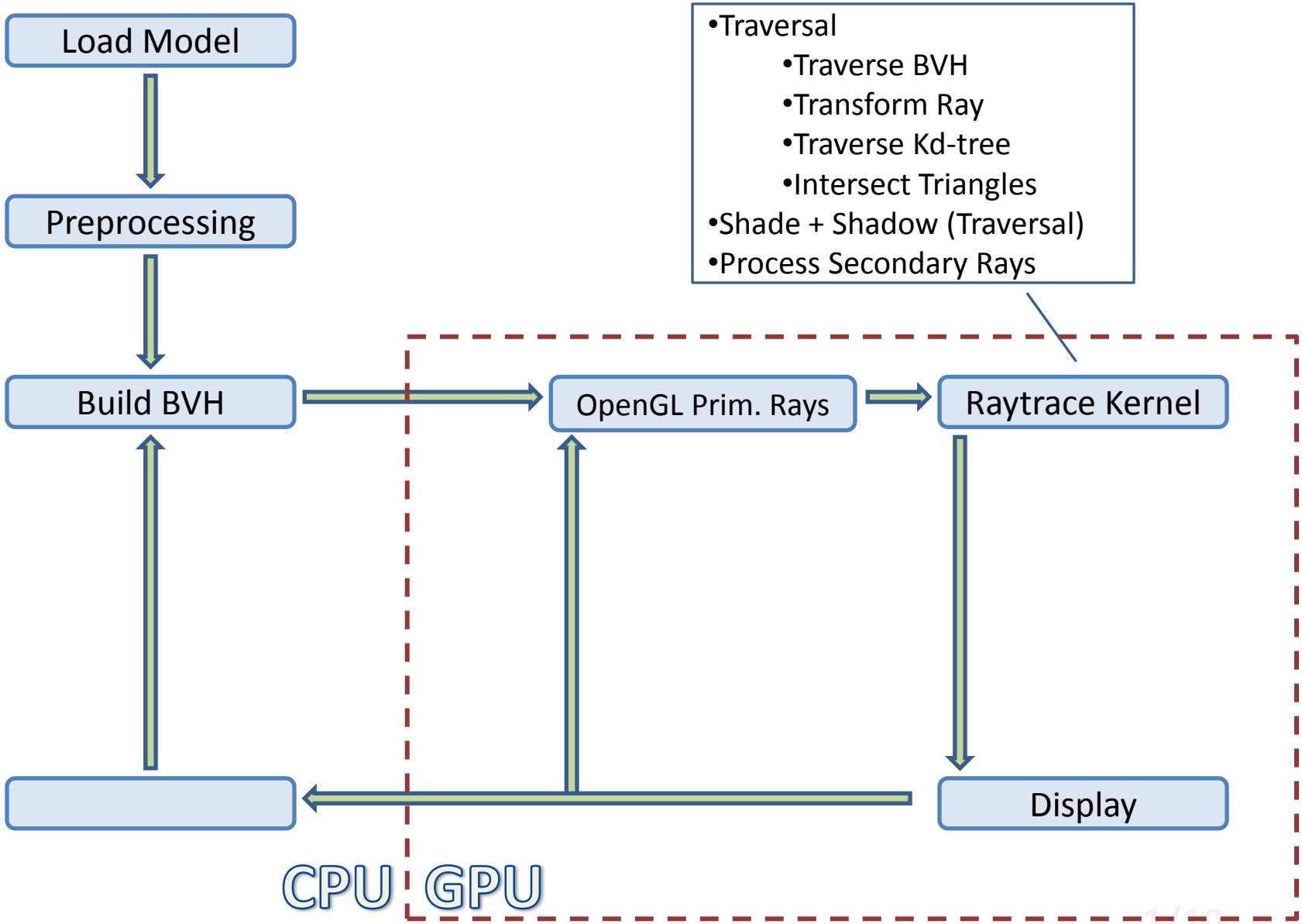
Approach – Two Level Hierarchy

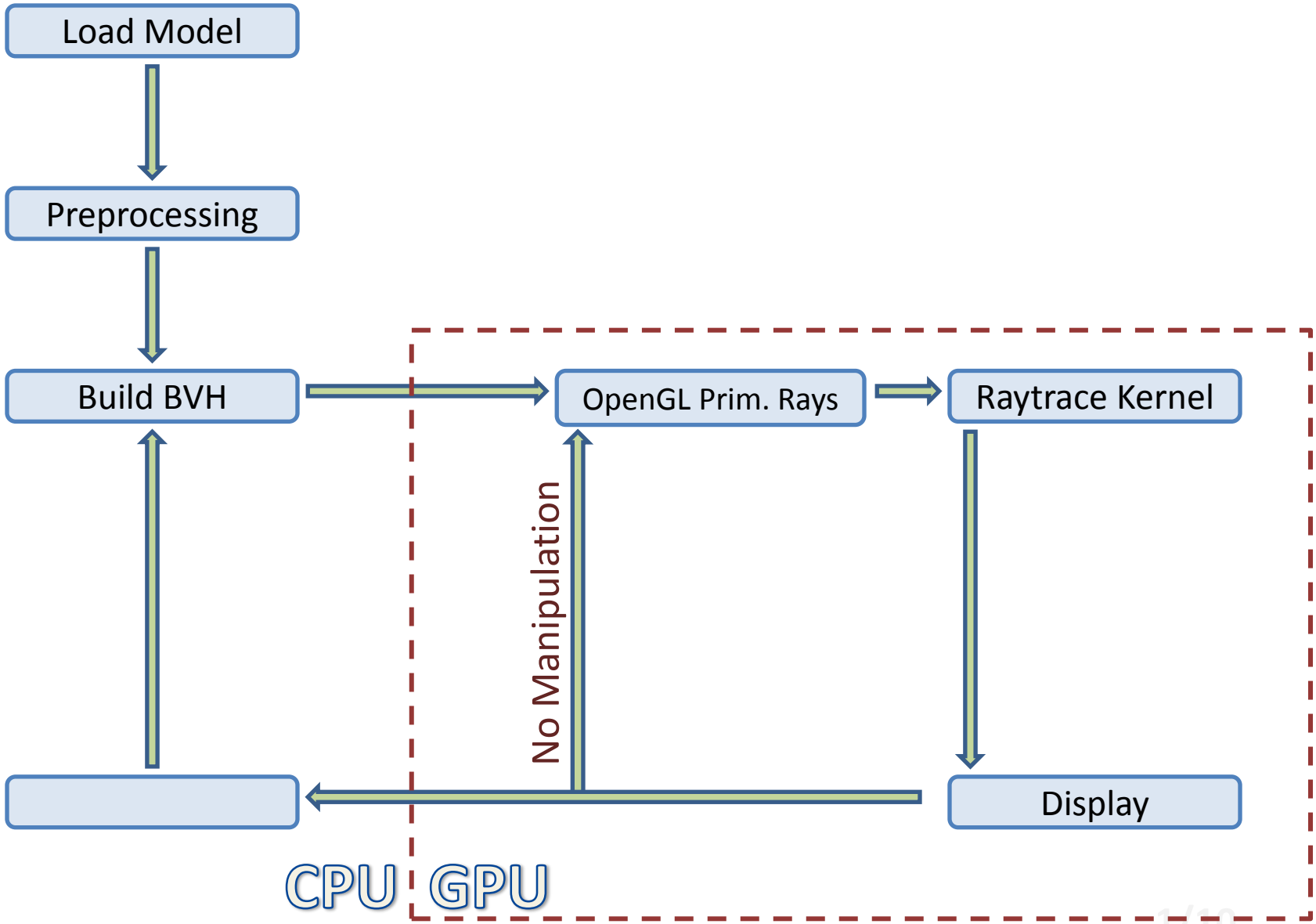


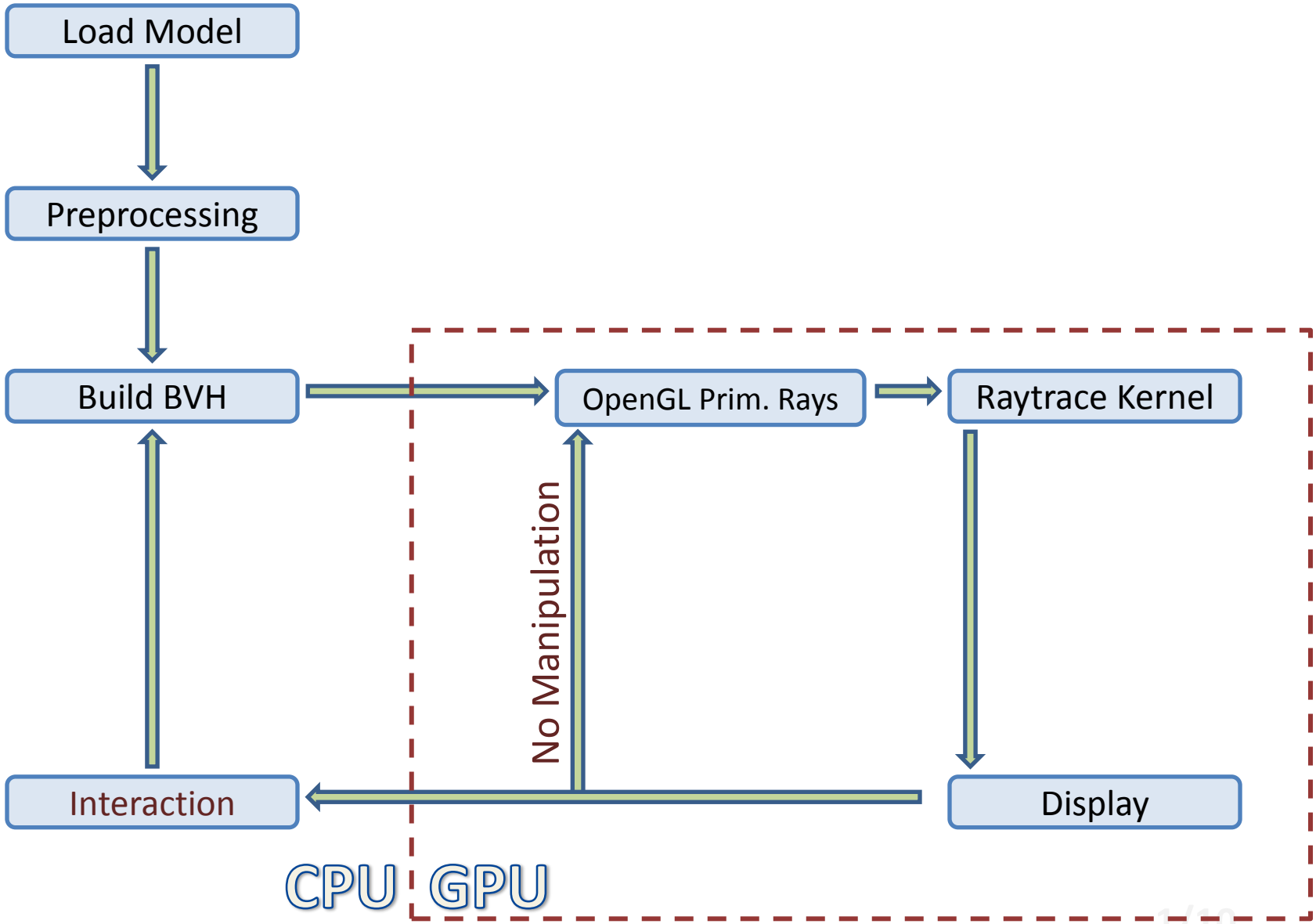

Load Model
•Load .obj + .mtl
•Generate Textures
•Materials
•Geometry (Vertices, Normals)
•Transformation Matrices
Display
CPU
GPU


Load Model
Preprocessing
•OOBB Processing
•Build HQ Kd-tree for each object
•Serialize Kd-trees
•Generate Texture
Build BVH
•Build BVH < 10ms
•Serialize BVH
•Generate Texture
Display
CPU
GPU

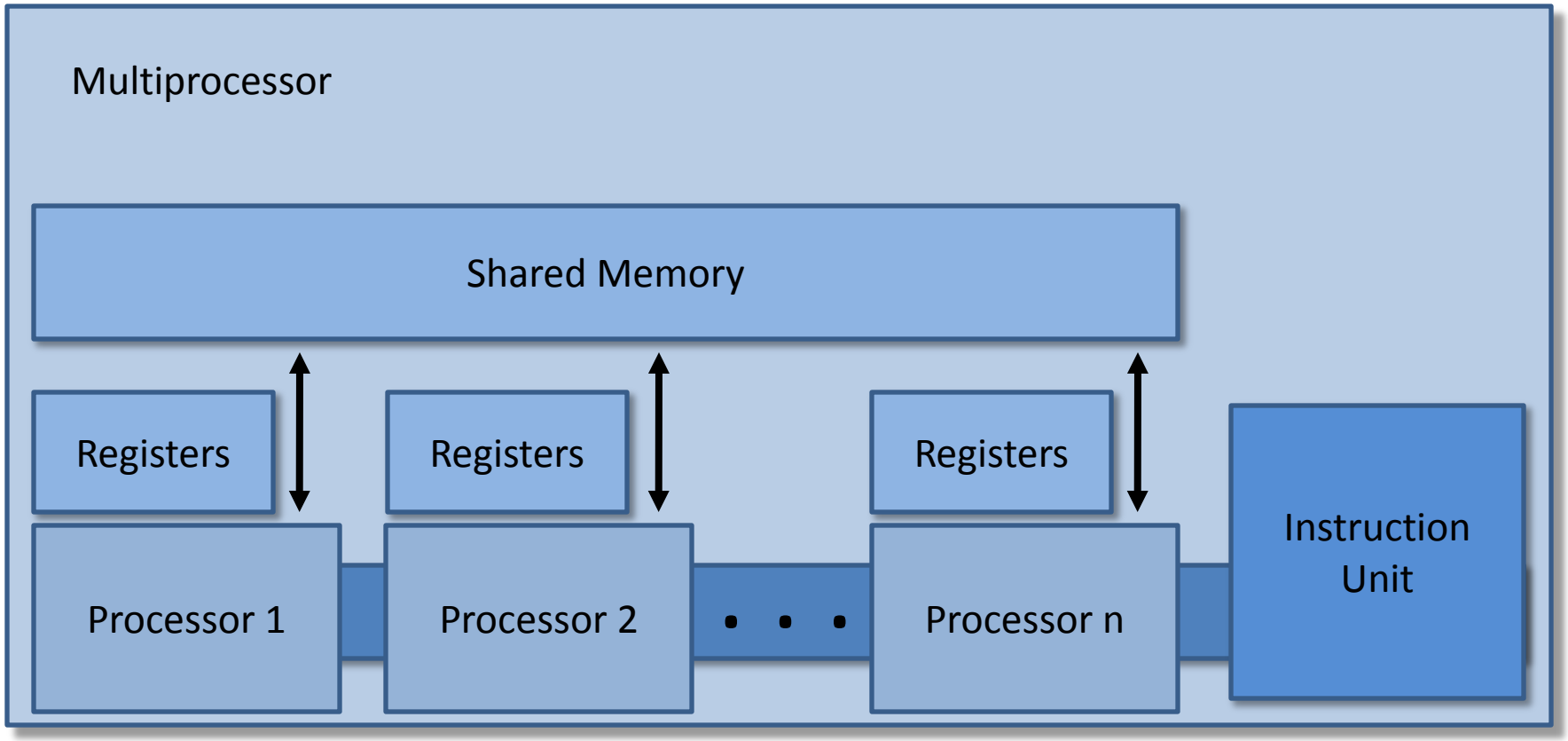

Load Model
Preprocessing
Build BVH
OpenGL Prim. Rays
•Triangle IDs
•UV - Parameters
Display
CPU
GPU


Load Model
Preprocessing
Build BVH
OpenGL Prim. Rays
Raytrace Kernel
Display
•Traversal
•Traverse BVH
•Transform Ray
•Traverse Kd-tree
•Intersect Triangles
•Shade + Shadow (Traversal)
•Process Secondary Rays
CPU
GPU

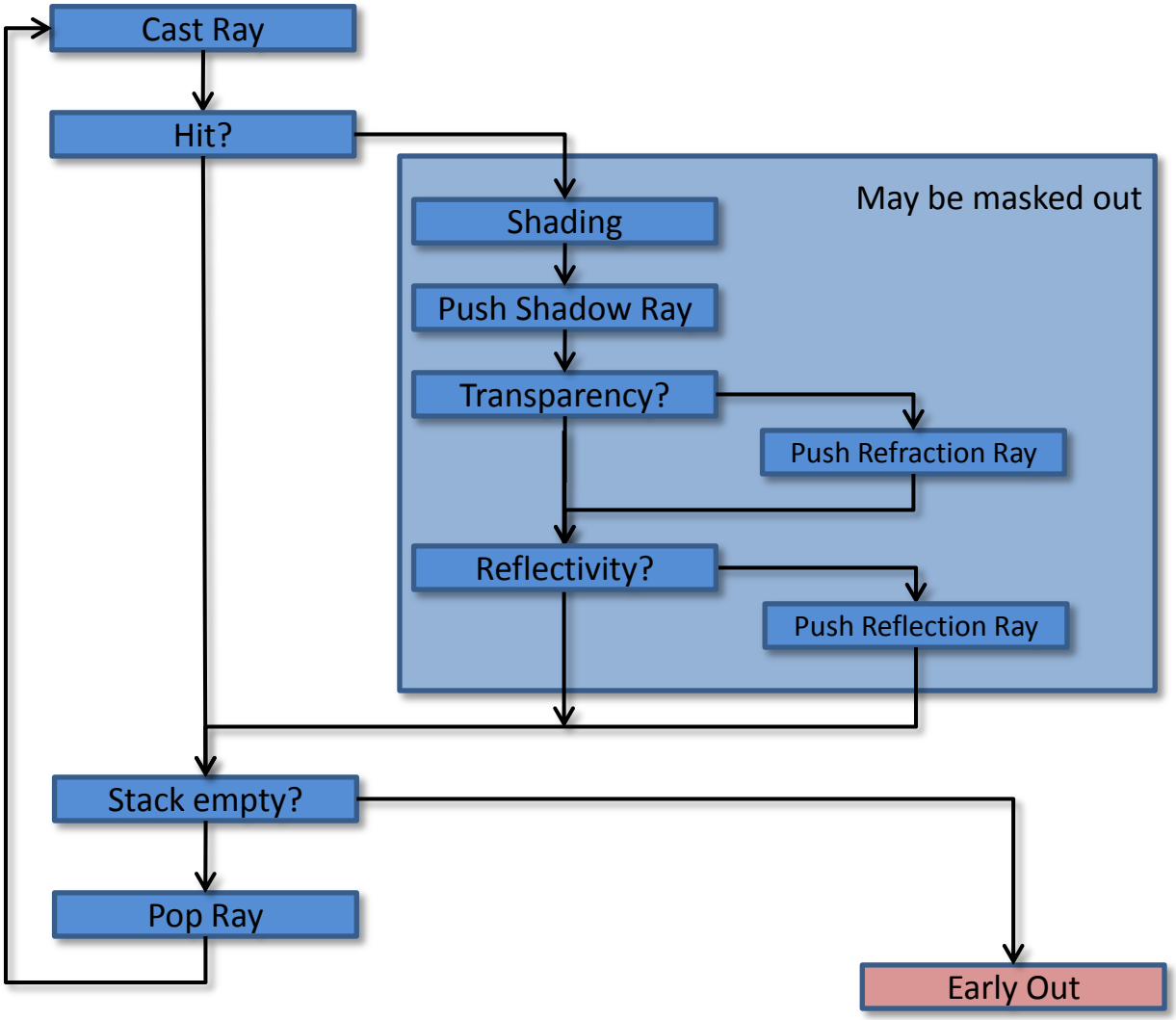

Load Model
Preprocessing
Build BVH
OpenGL Prim. Rays
Raytrace Kernel
No Manipulation
Display
CPU
GPU


Load Model
Preprocessing
Build BVH
OpenGL Prim. Rays
Raytrace Kernel
No Manipulation
Interaction
Display
CPU
GPU

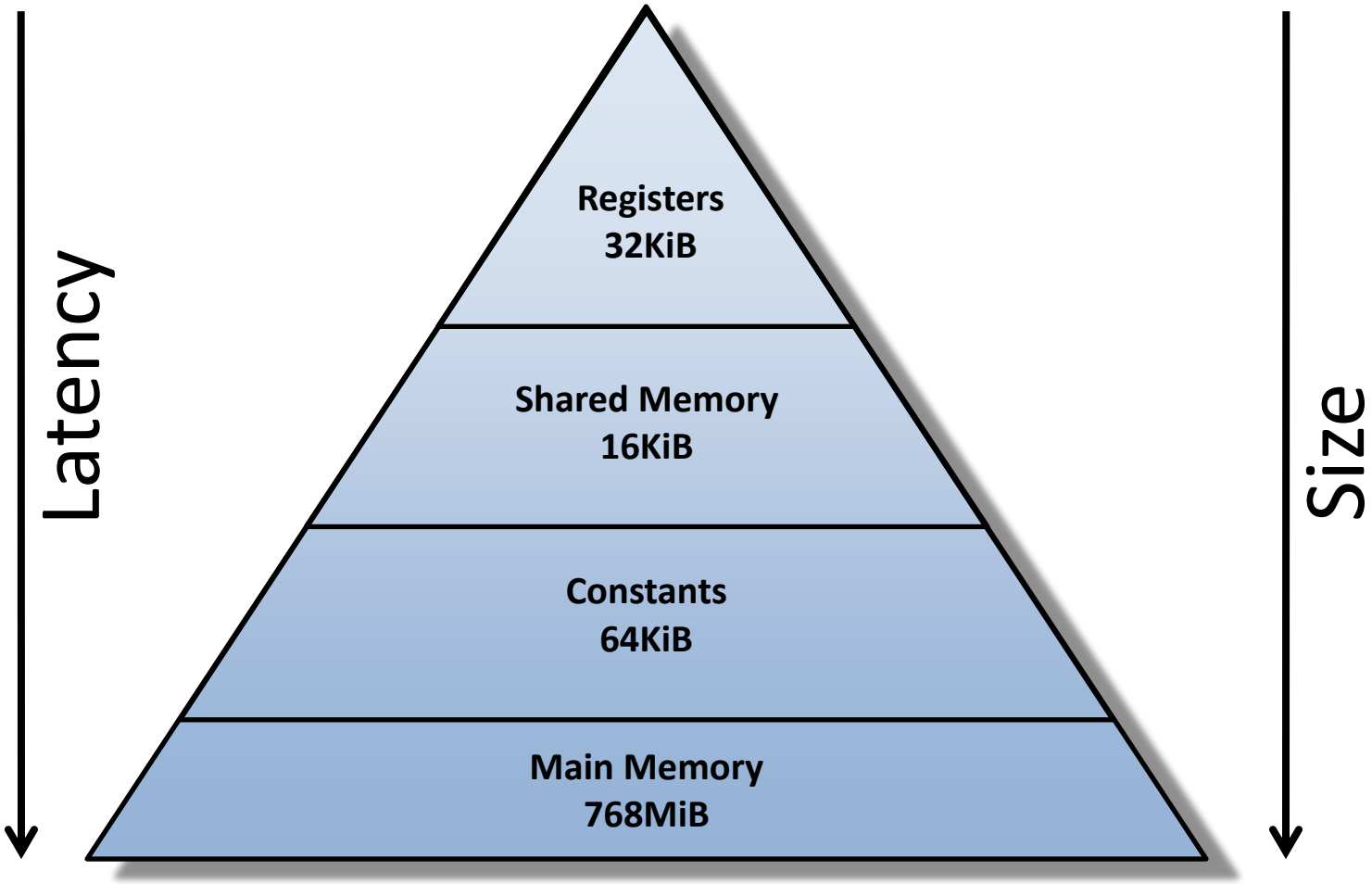
(Re-)Introducing CUDA



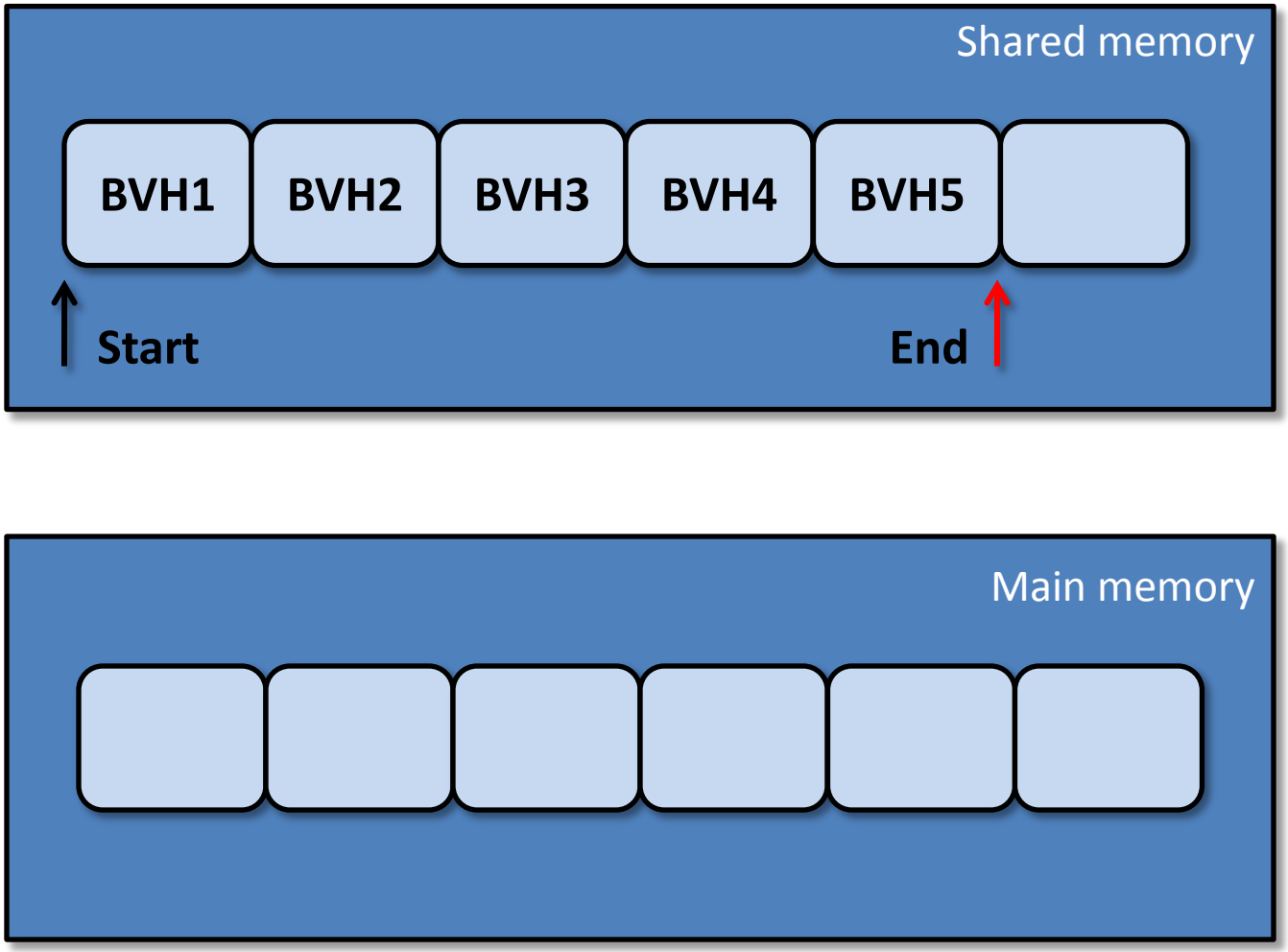
Branching Join Points



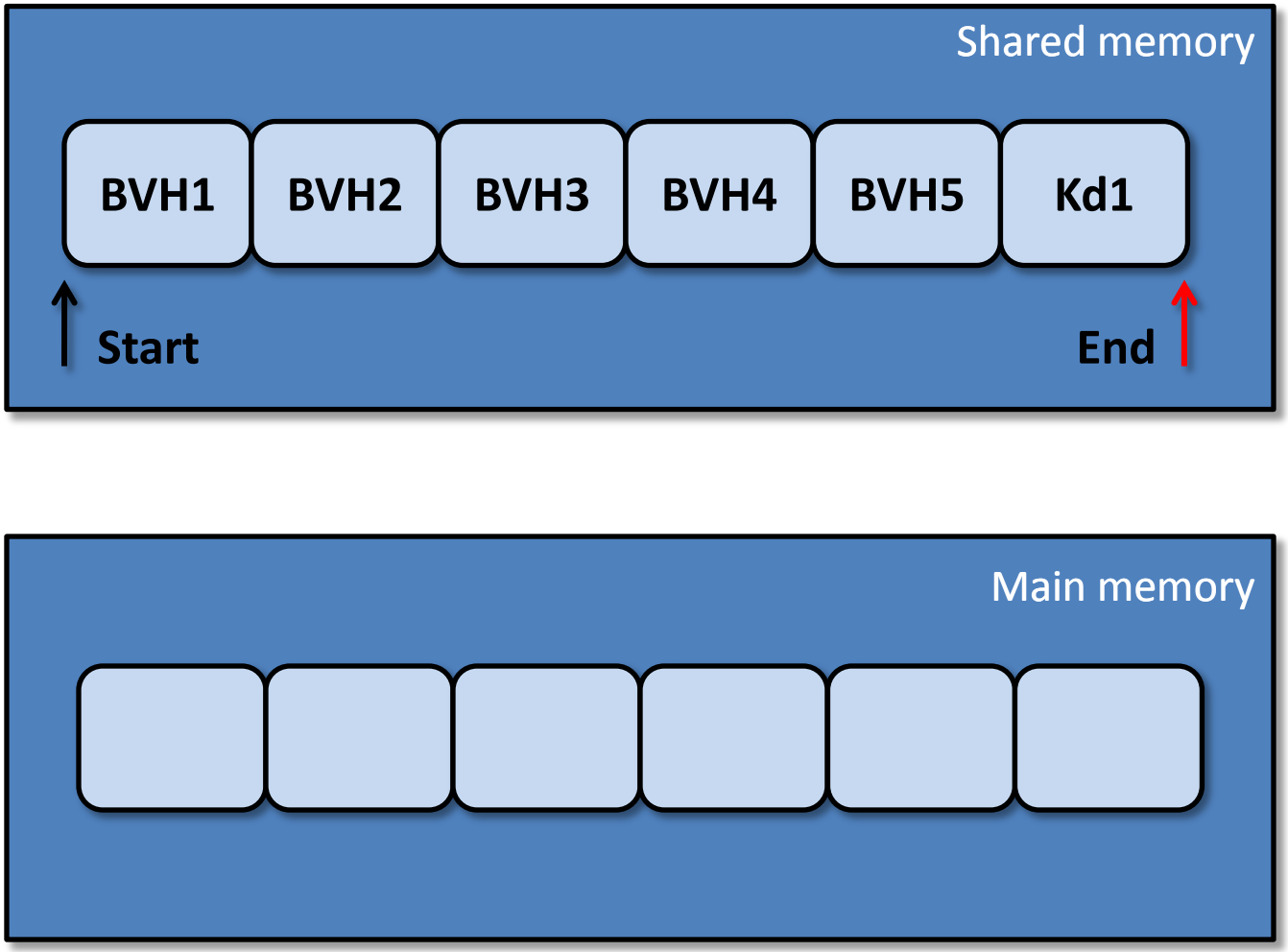
CUDA Memory Pyramid (8800GTX)



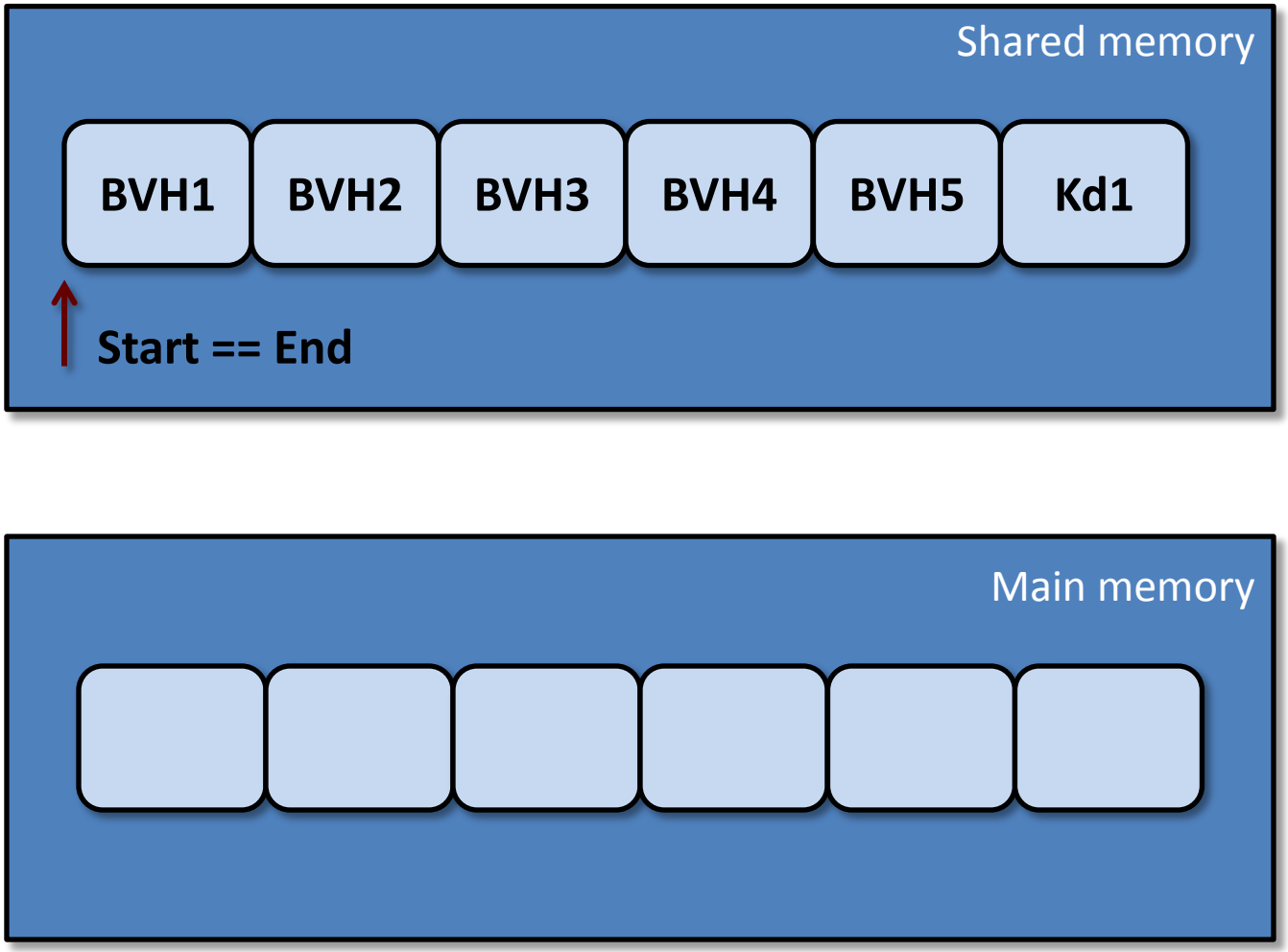
Smart Stack


Shared memory
BVH1
BVH2
BVH3
BVH4
BVH5
Start
End
Main memory

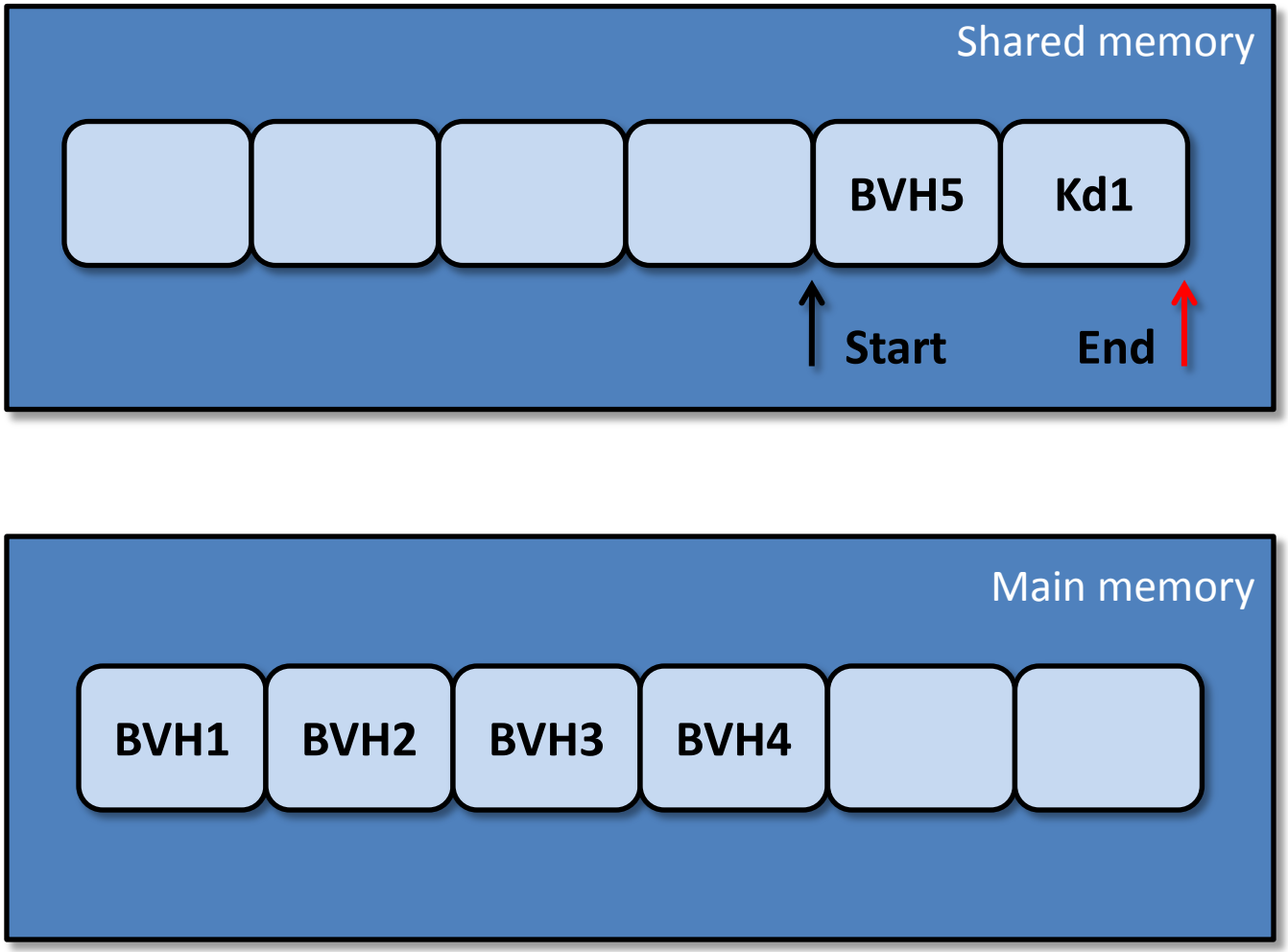
Smart Stack


Shared memory
BVH1
BVH2
BVH3
BVH4
BVH5
Kd1
Start
End
Main memory

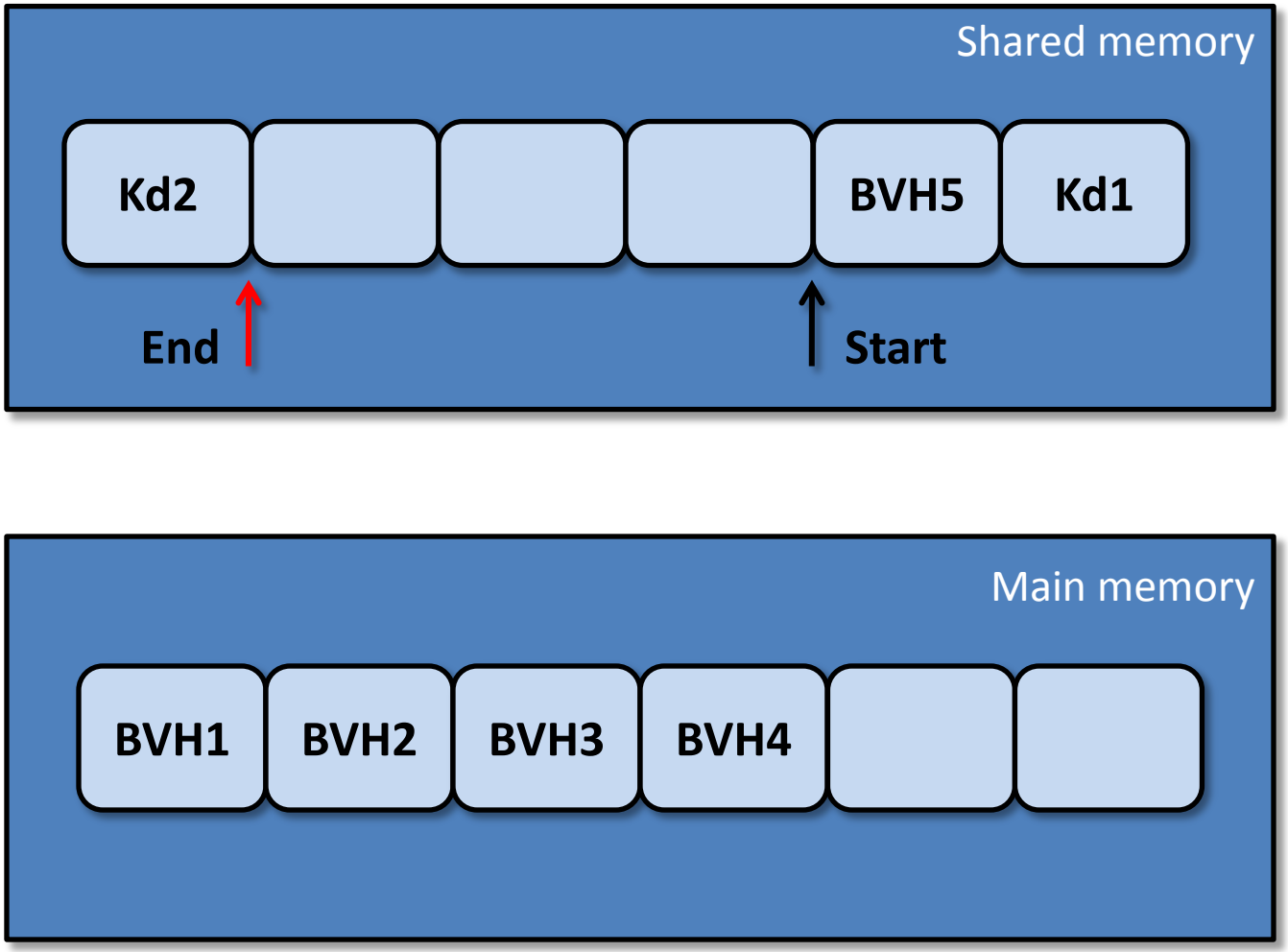
Smart Stack


Shared memory
BVH1
BVH2
BVH3
BVH4
BVH5
Kd1
Start == End
Main memory

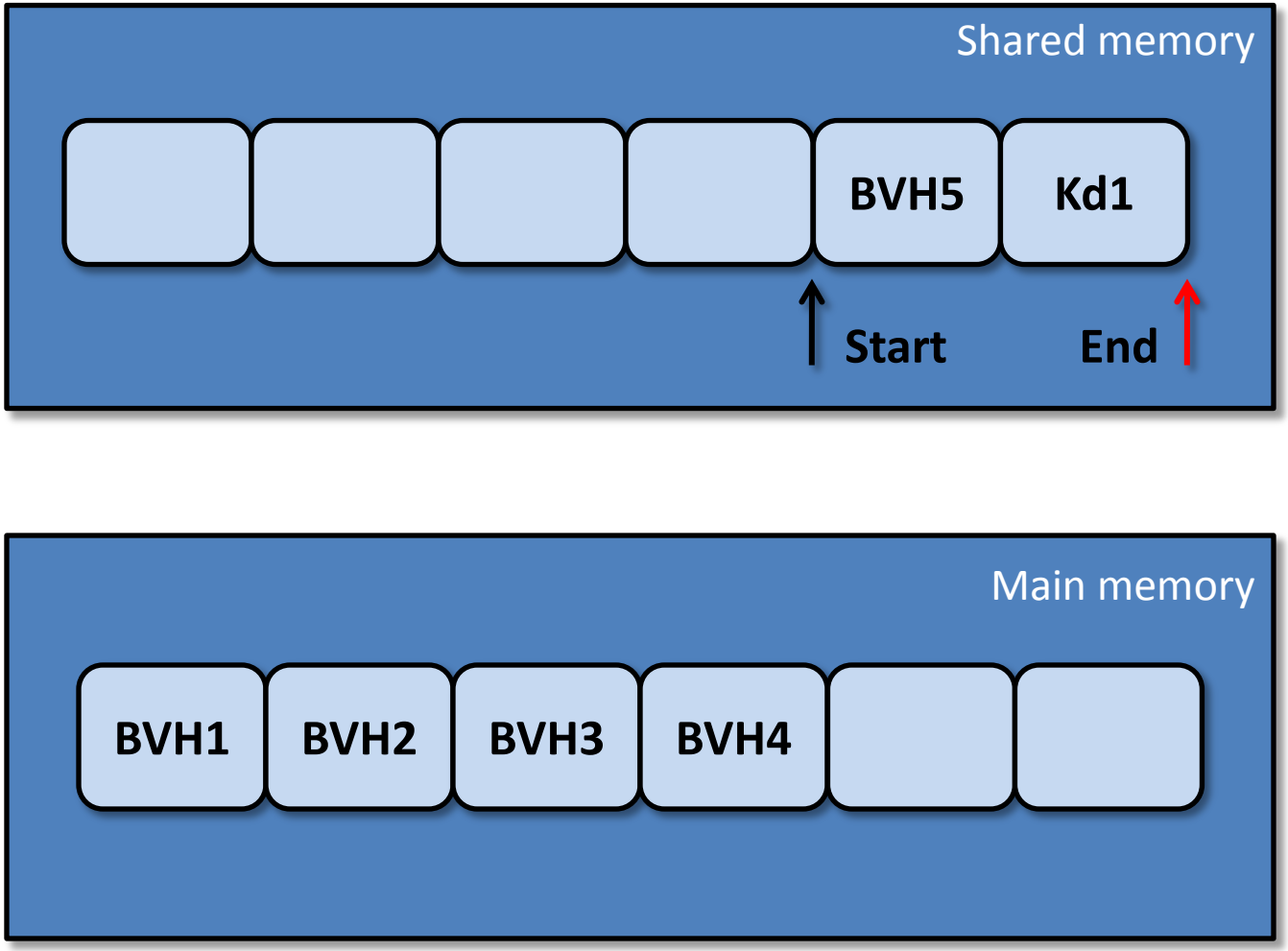
Smart Stack


Shared memory
BVH5
Kd1
Start
End
Main memory
BVH1
BVH2
BVH3
BVH4

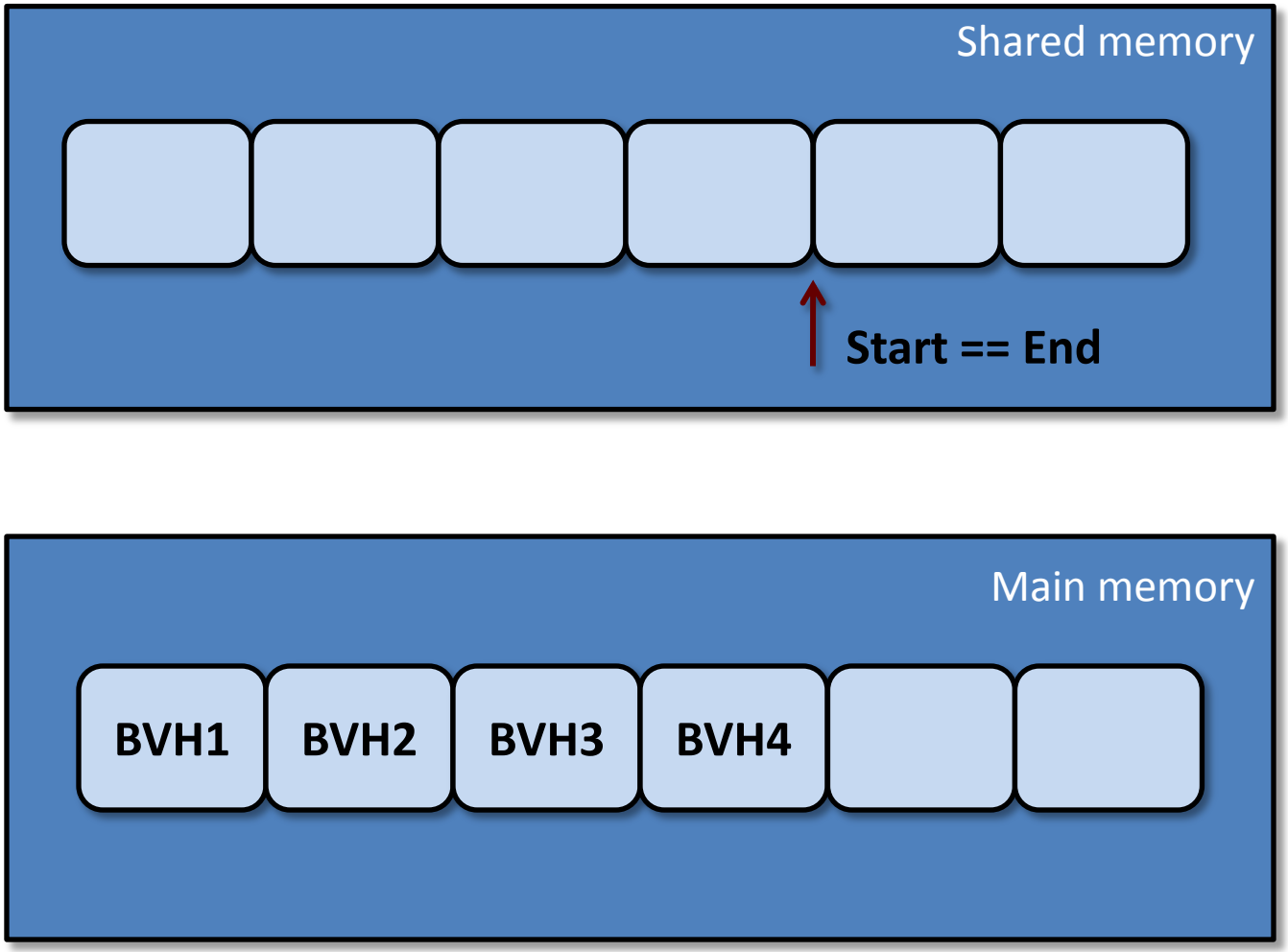
Smart Stack


Shared memory
Kd2
BVH5
Kd1
End
Start
Main memory
BVH1
BVH2
BVH3
BVH4

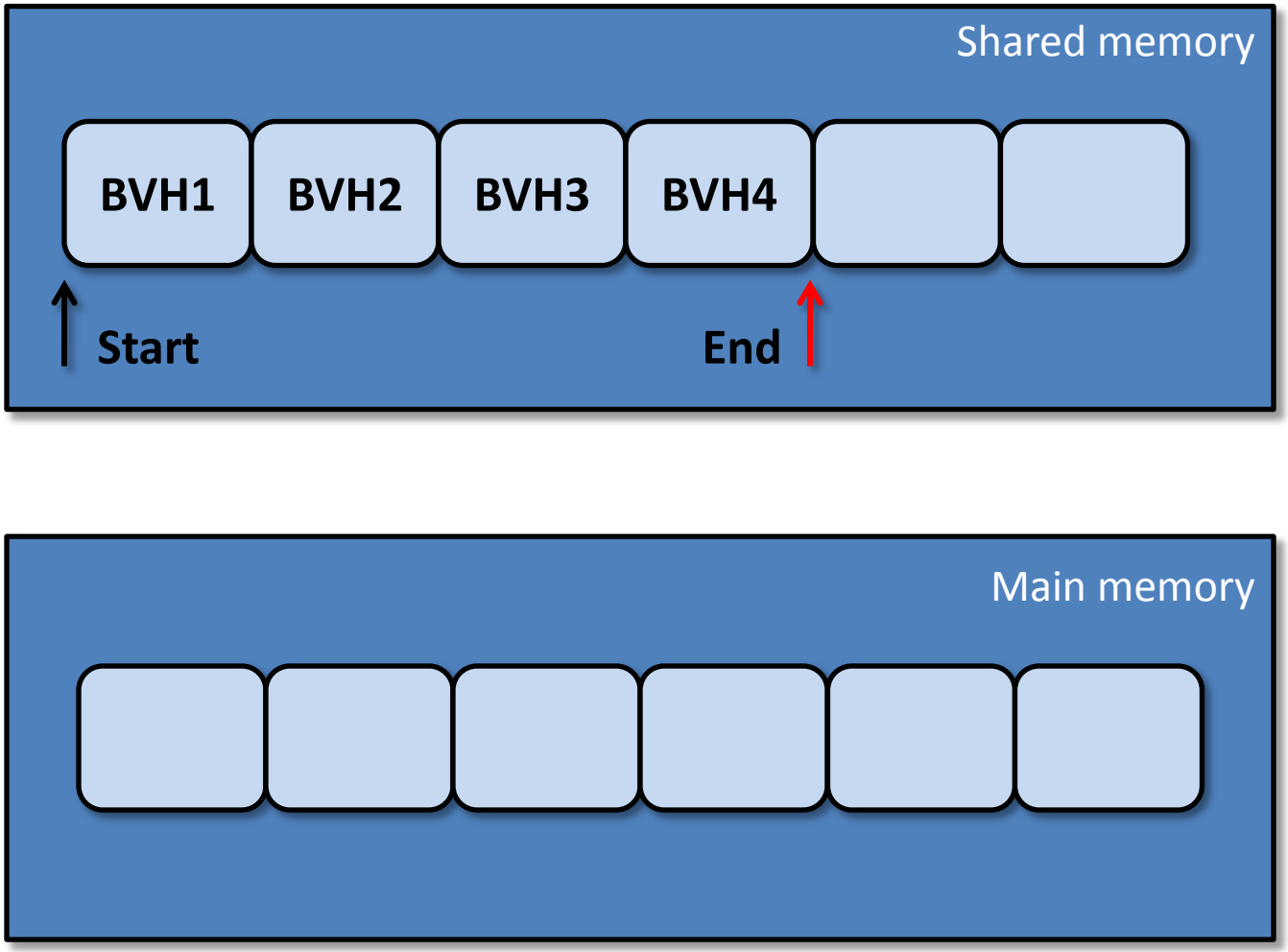
Smart Stack


Shared memory
BVH5
Kd1
Start
End
Main memory
BVH1
BVH2
BVH3
BVH4

Smart Stack

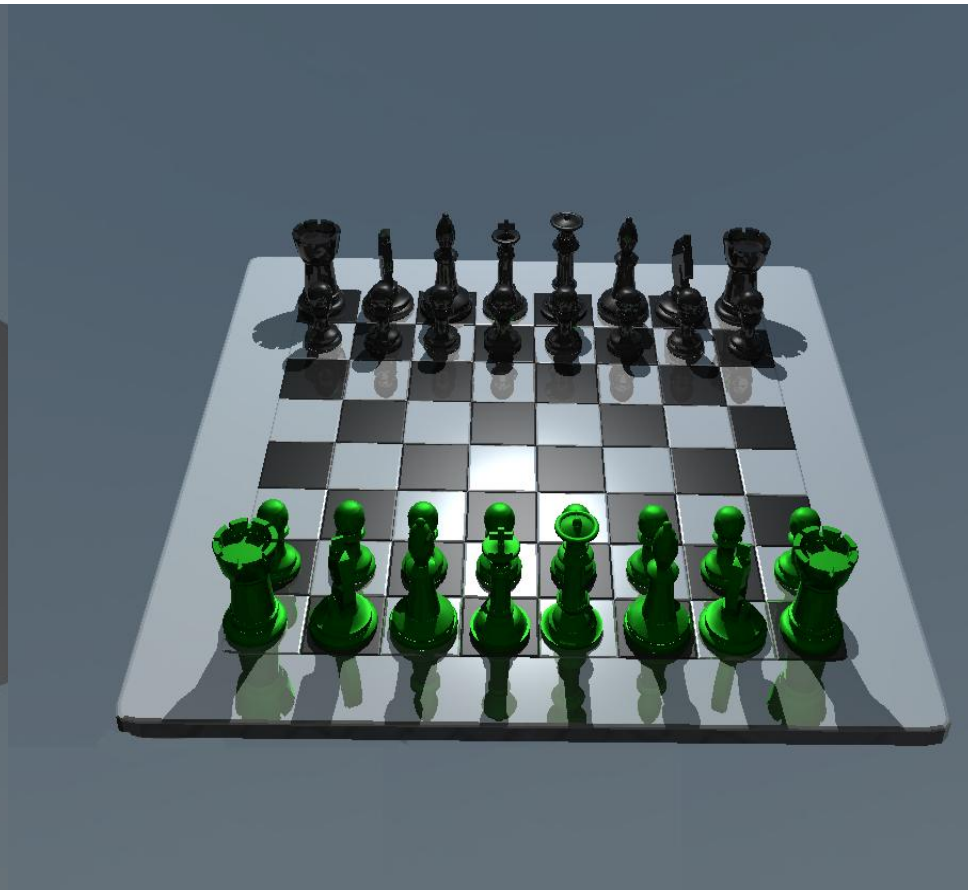


Smart Stack



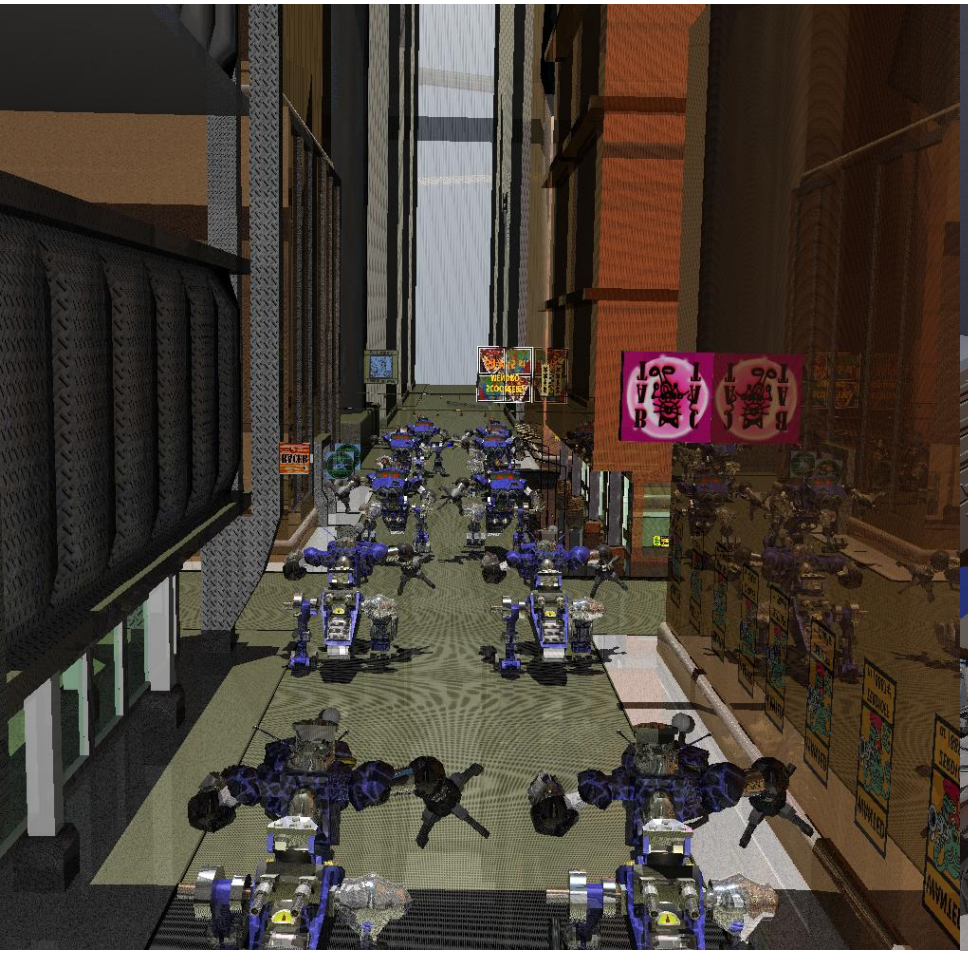
Results & Performance Evaluation

Chevy · 43k tris · 79 objects



Chess · 46k tris · 34 objects

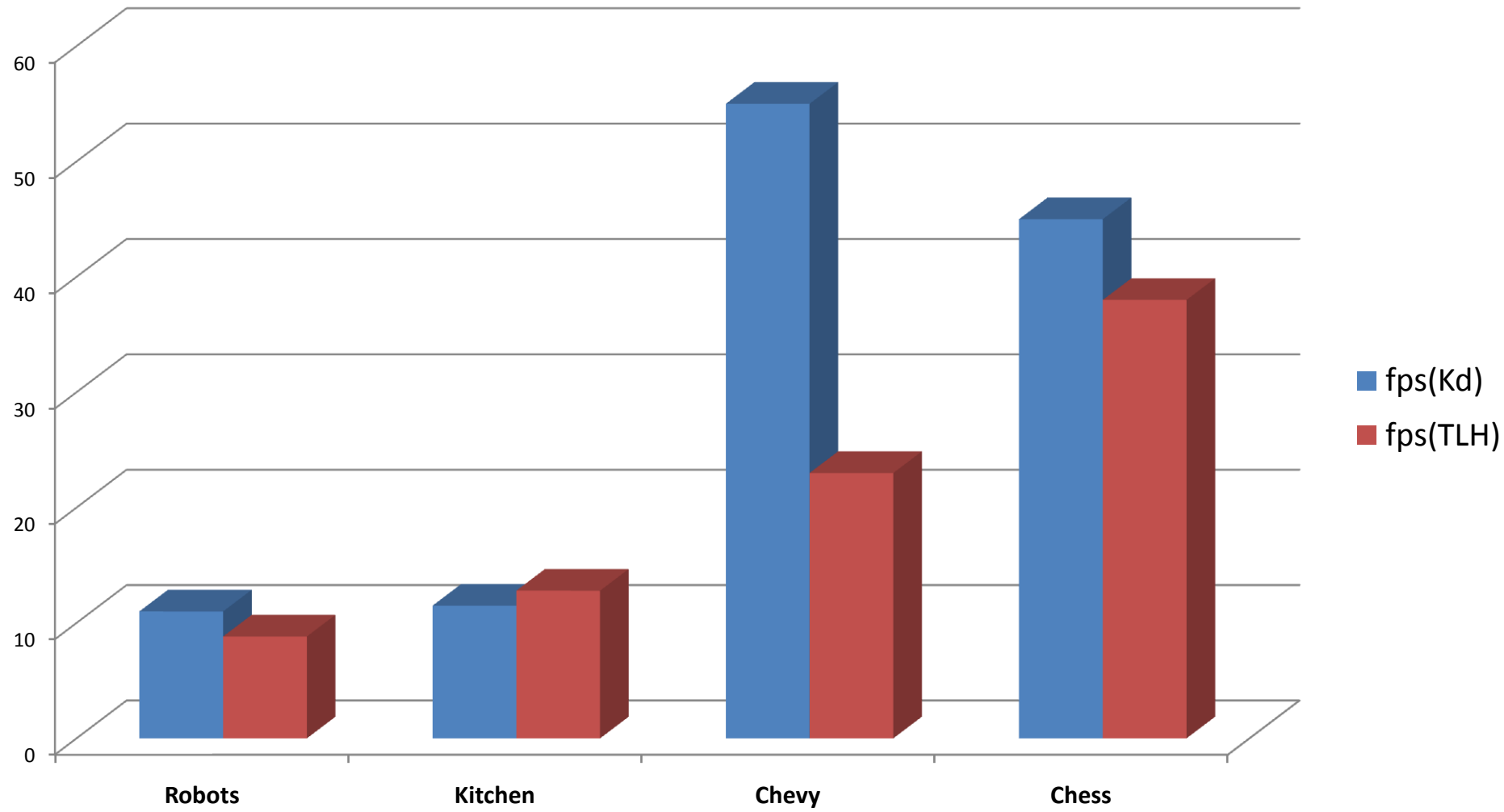
Results & Performance Evaluation



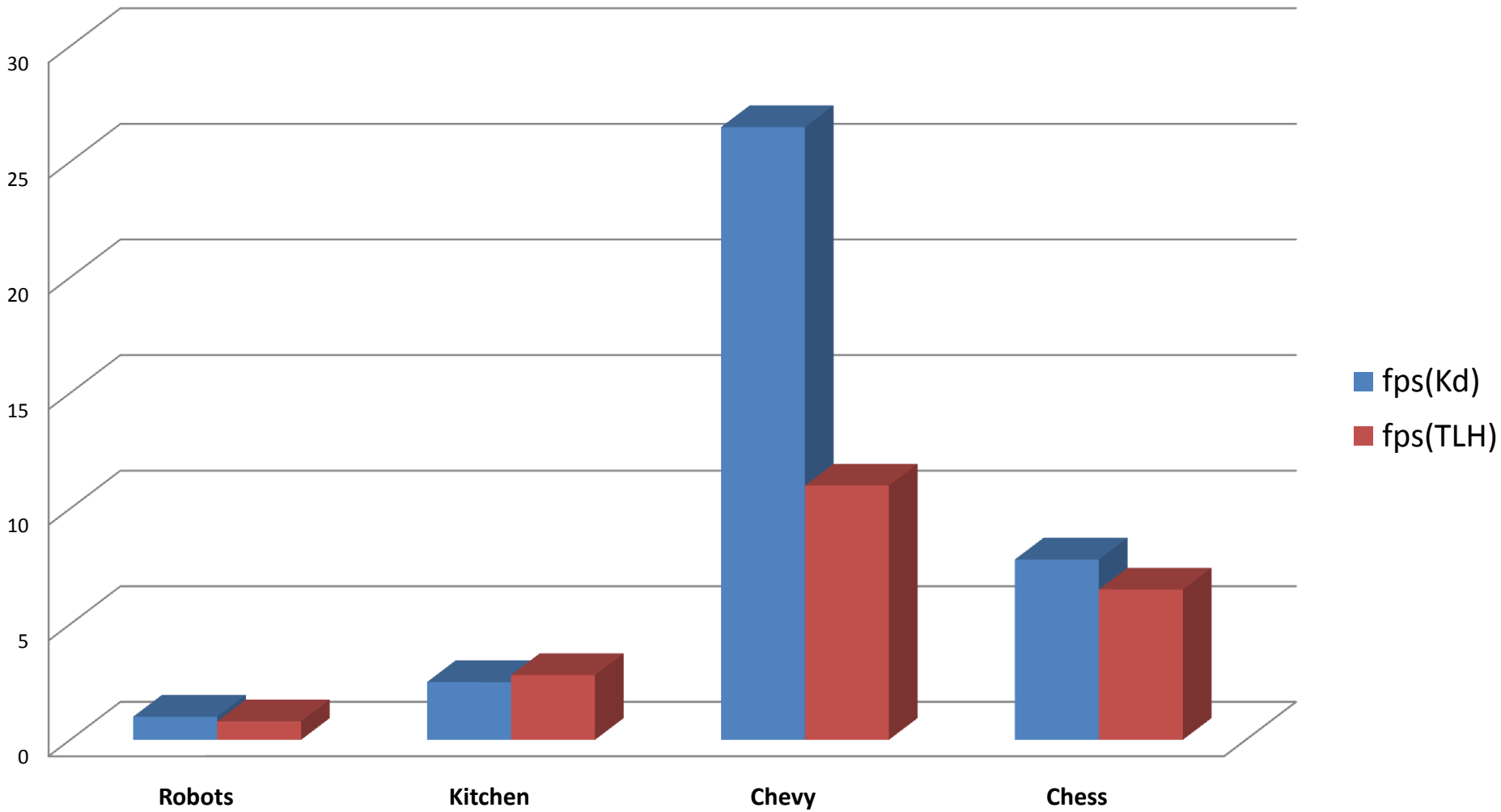
BART Robots · 110k tris · 162 objects

BART Kitchen · 71k tris · 5 objects

Performance Impact Shadow Rays



Performance Impact Secondary Rays



Conclusion & Future Work

- Dynamic Scenes / Two-Level Hierarchy
- Smart Stack
- Performance
- HW Occupancy

today

---

tomorrow

- Kd-Kd : The better approach?
- Kd-split / Kd-merge


Thank you!