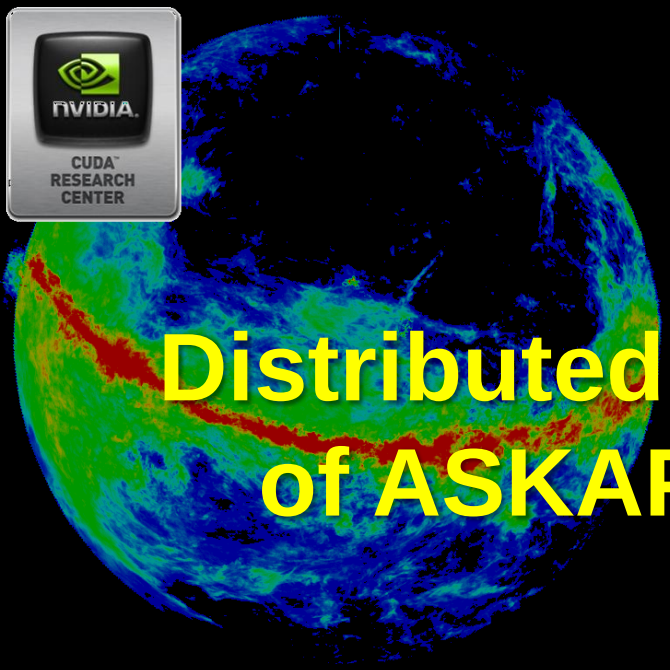
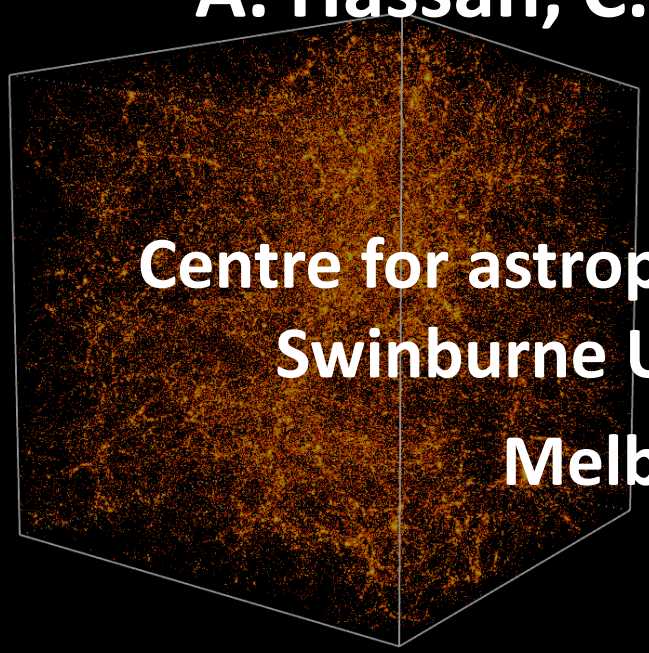
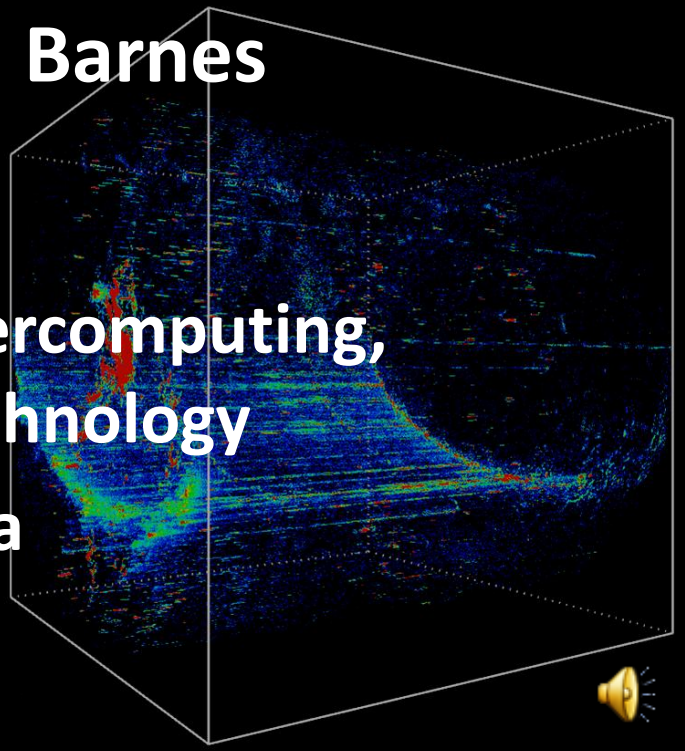


Distributed GPU Volume Rendering of ASKAP Spectral Data Cubes

A. Hassan, C. J. Fluke, D. G. Barnes

Centre for astrophysics and supercomputing,
Swinburne University of Technology
Melbourne, Australia





Petascale Astronomy Era

Radio Telescopes

ASKAP : 2.5 TB/Cube

Optical Telescopes

SkyMapper : 100 MB/s
500 TB Southern Sky Survey

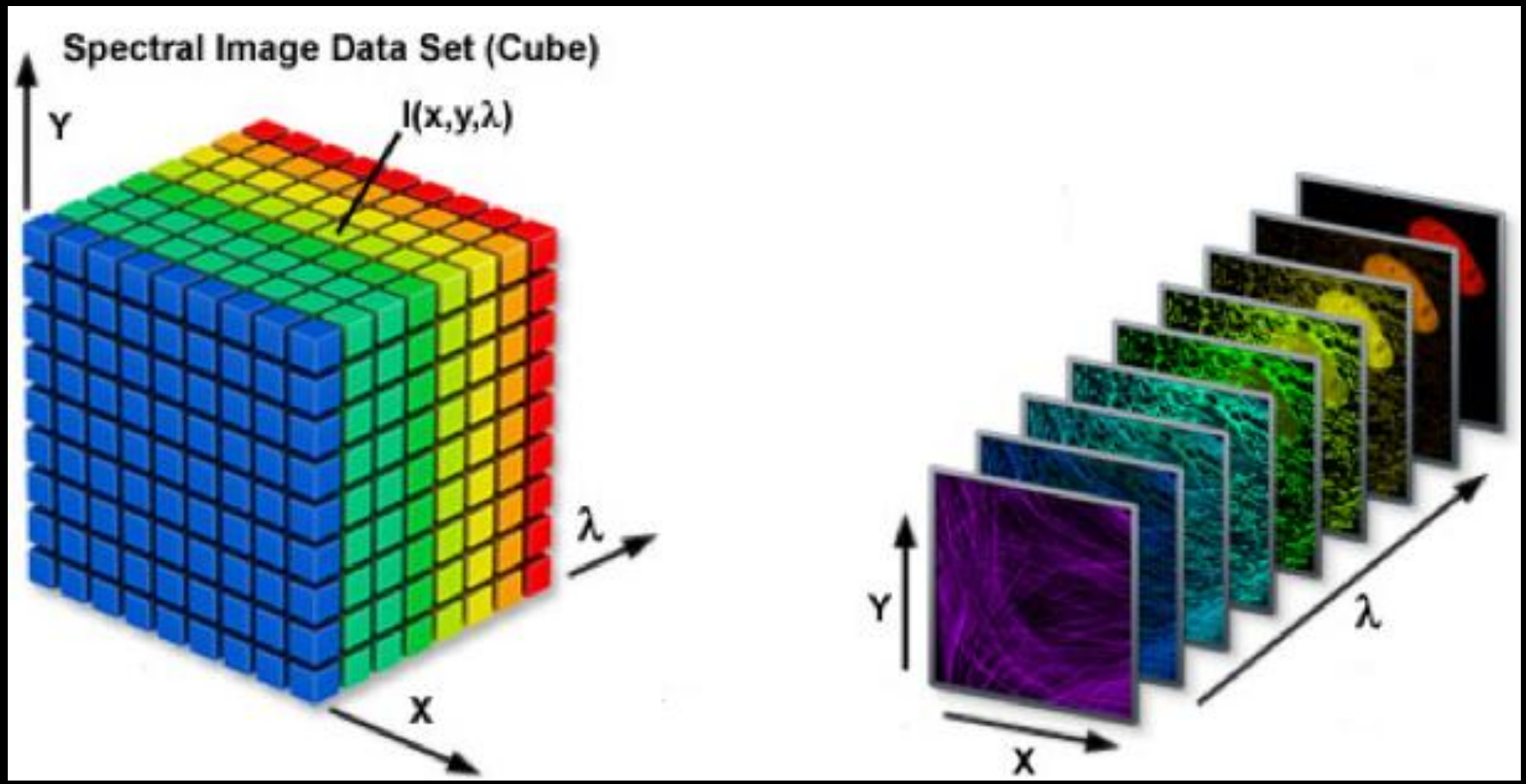
©spaceinfo.com.au

©atnf.csiro.au

Parameter	Value	
	Low resolution	***High resolution***
Maximum baseline	2 Km	6 Km
Angular resolution (z=0)	30 arcsec	10 arcsec
Number of beams	36	36
Number of channels	16384	16384
Observation time per cube	8 Hours	8 Hours
Pixel size	10 arcsec	2.5 arcsec
Image size	2048 x 2048 pixels	8192 x 8192 pixels
Cube size	0.28 TB	4.4 TB

Data Processing and Release for ASKAP HI Surveys
Lister Staveley-Smith et. al. (2010)

What is Spectral Data Cube?



Why not to use the current 2D methods?

ASKAP Cube Dimensions 8192 x 8192 x 16384

10 fps ≈ 30 Minutes

But we don't have a 8k x 8k screens !

ASKAP Cube Dimensions into 8x8 Grid ≈ 64 x 1024 x 1024 x 16384

10 fps → 64 x 27.3 Minutes ≈ 30 Hours

Each Cube 64 GB

What we are proposing

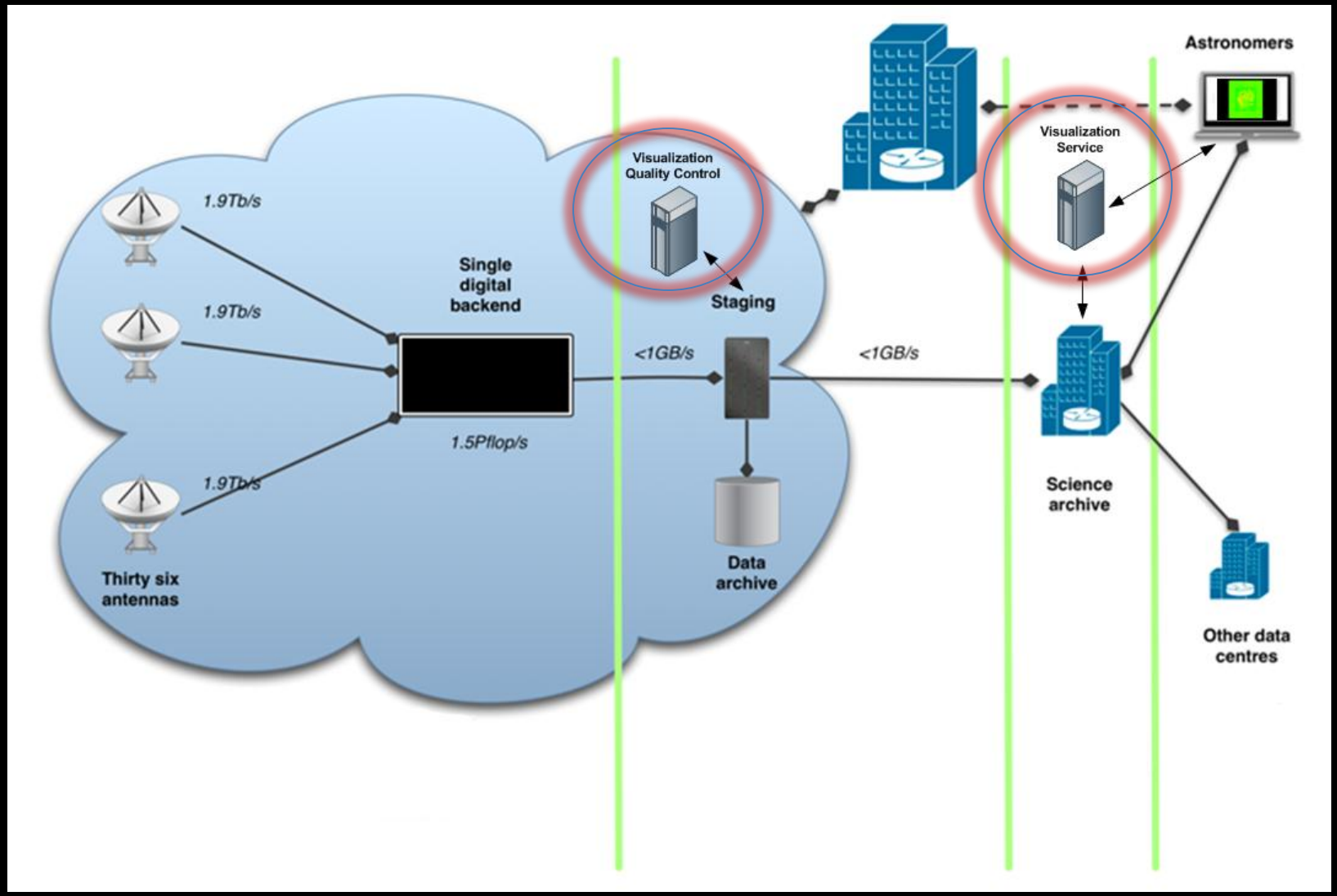
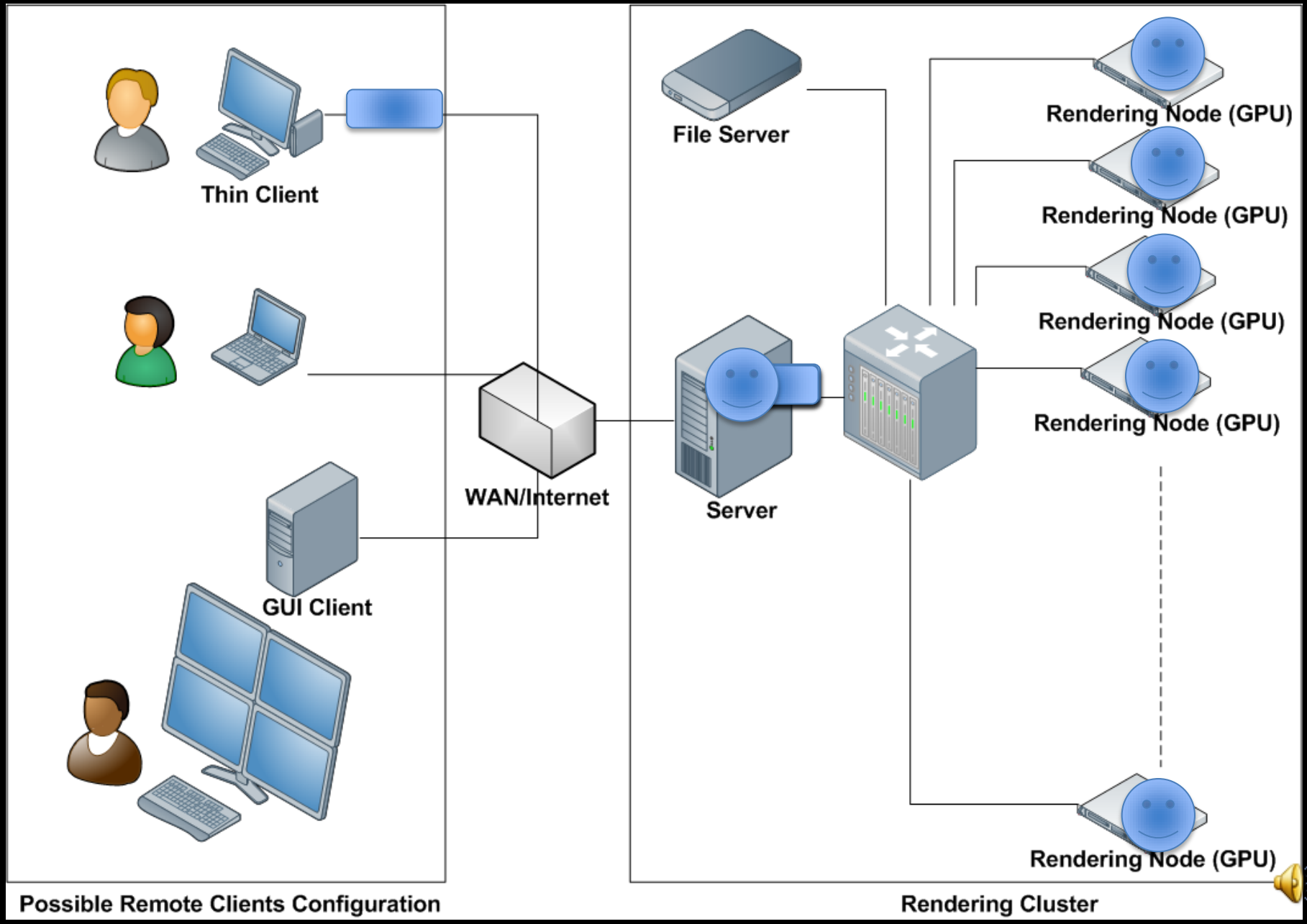
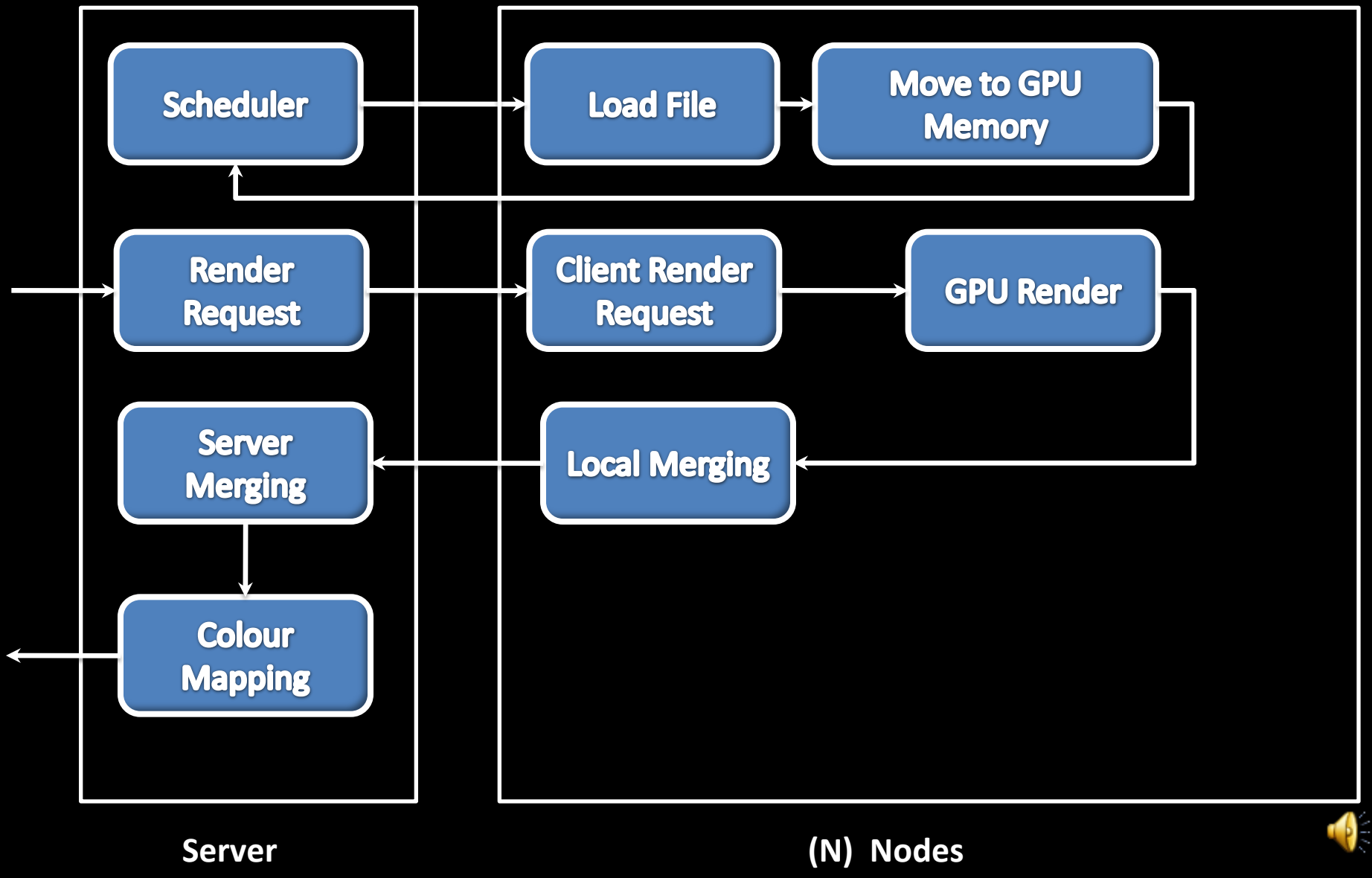


Image Source : ASKAP Computing - ASKAIC Technical Update “Towards SKA - ASKAP computing & the development of SKA systems” - Ben Humphreys – CSIRO

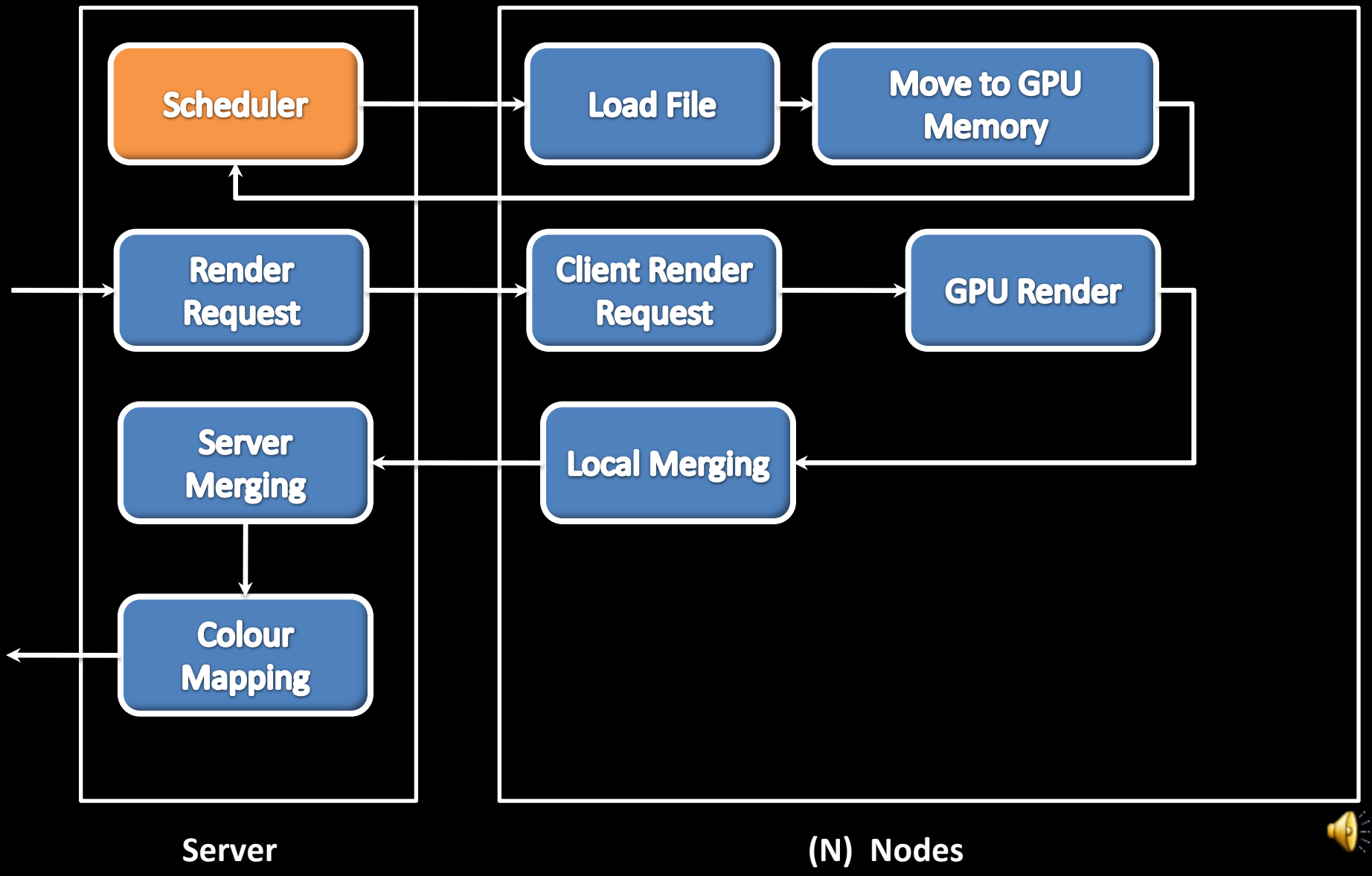
Proposed System Configuration



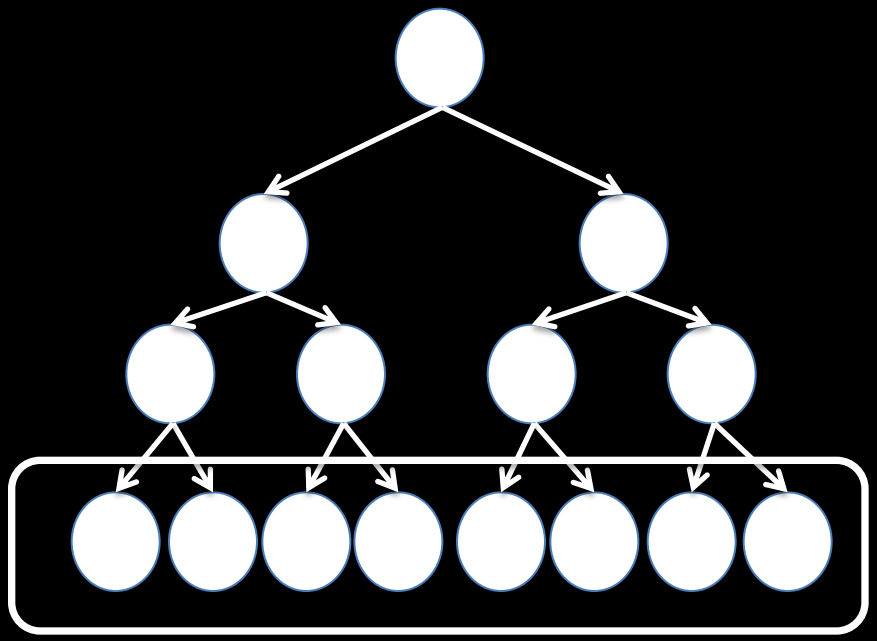
Framework Design

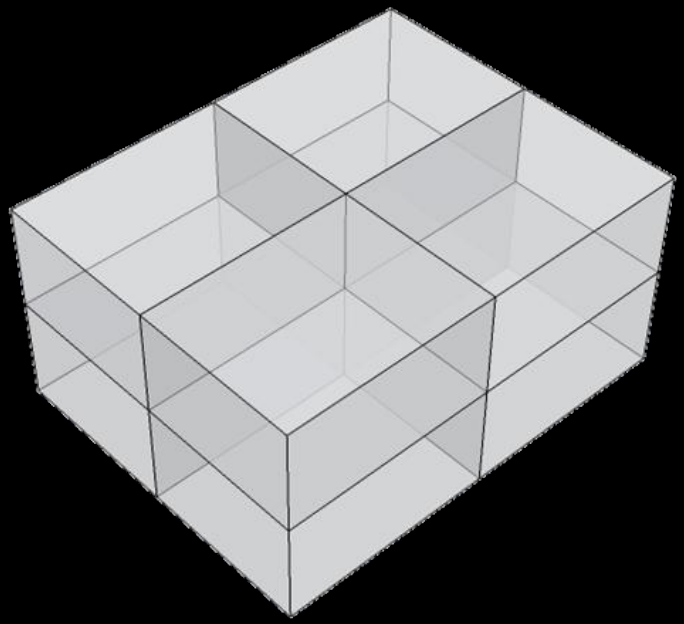


Framework Design



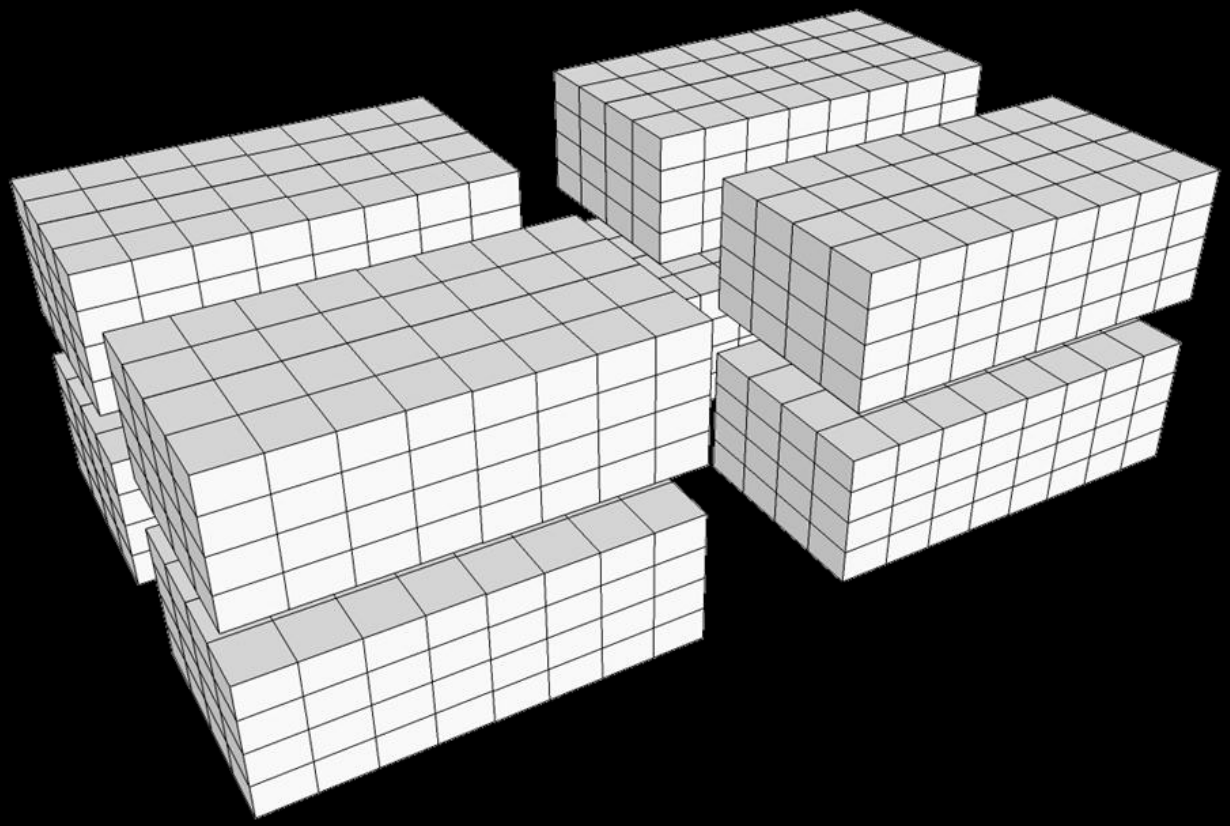
Scheduler



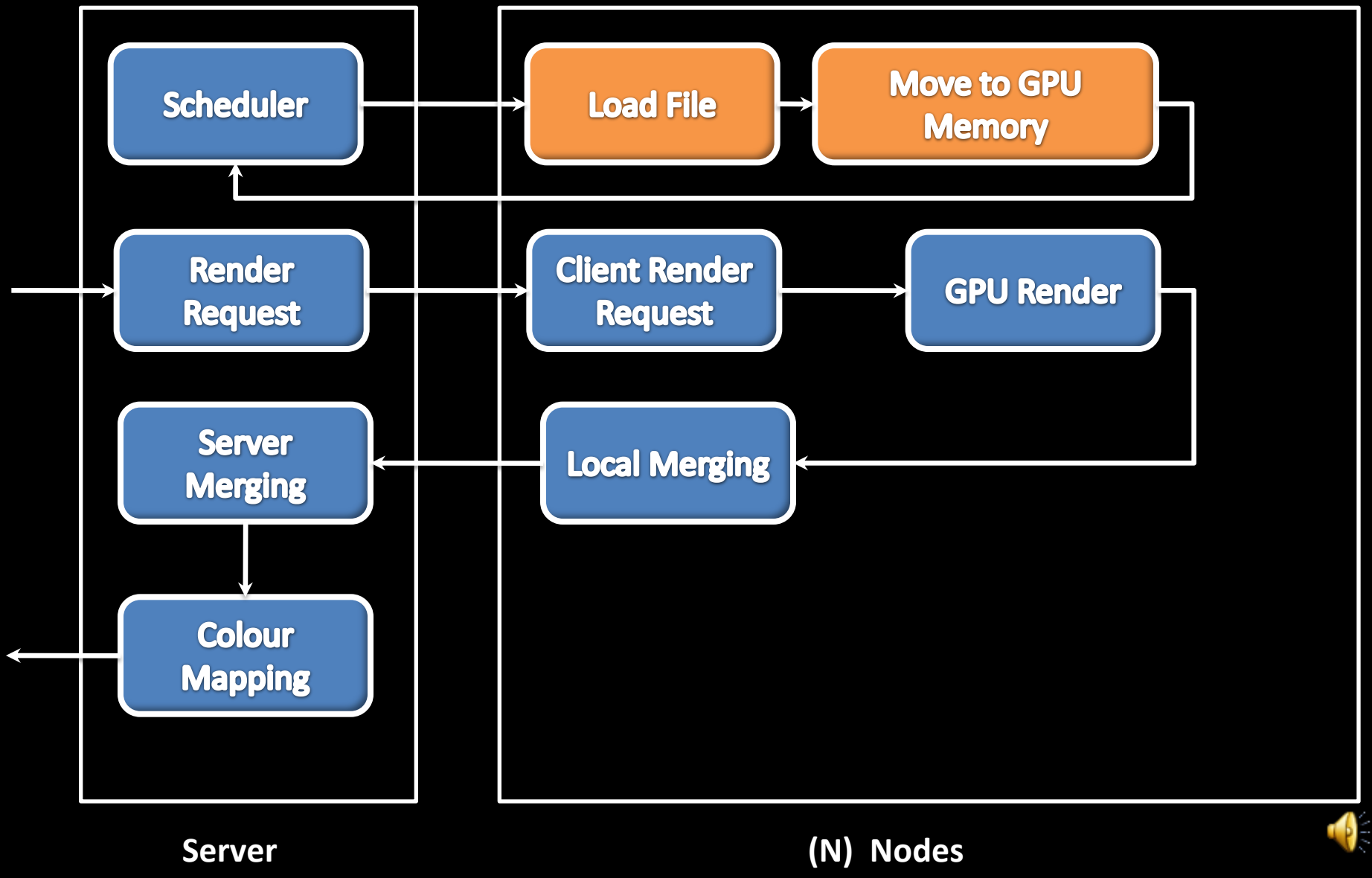


Scheduler

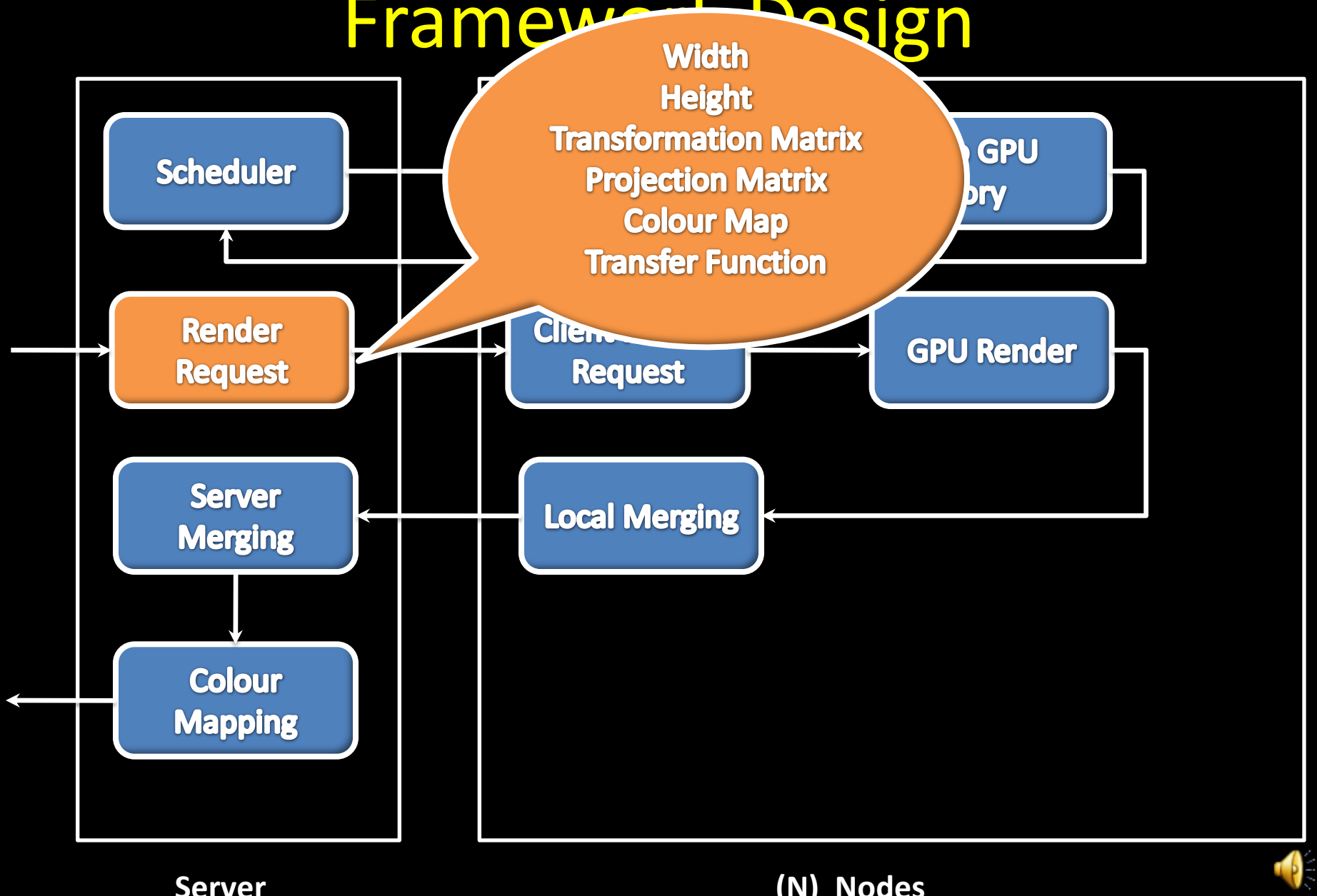
- Node 1 – GPU 1
- Node 1 – GPU 2
- Node 2 – GPU 1
- Node 2 – GPU 2
- Node 3 – GPU 1
- Node 3 – GPU 2
- Node 4 – GPU 1
- Node 4 – GPU 2



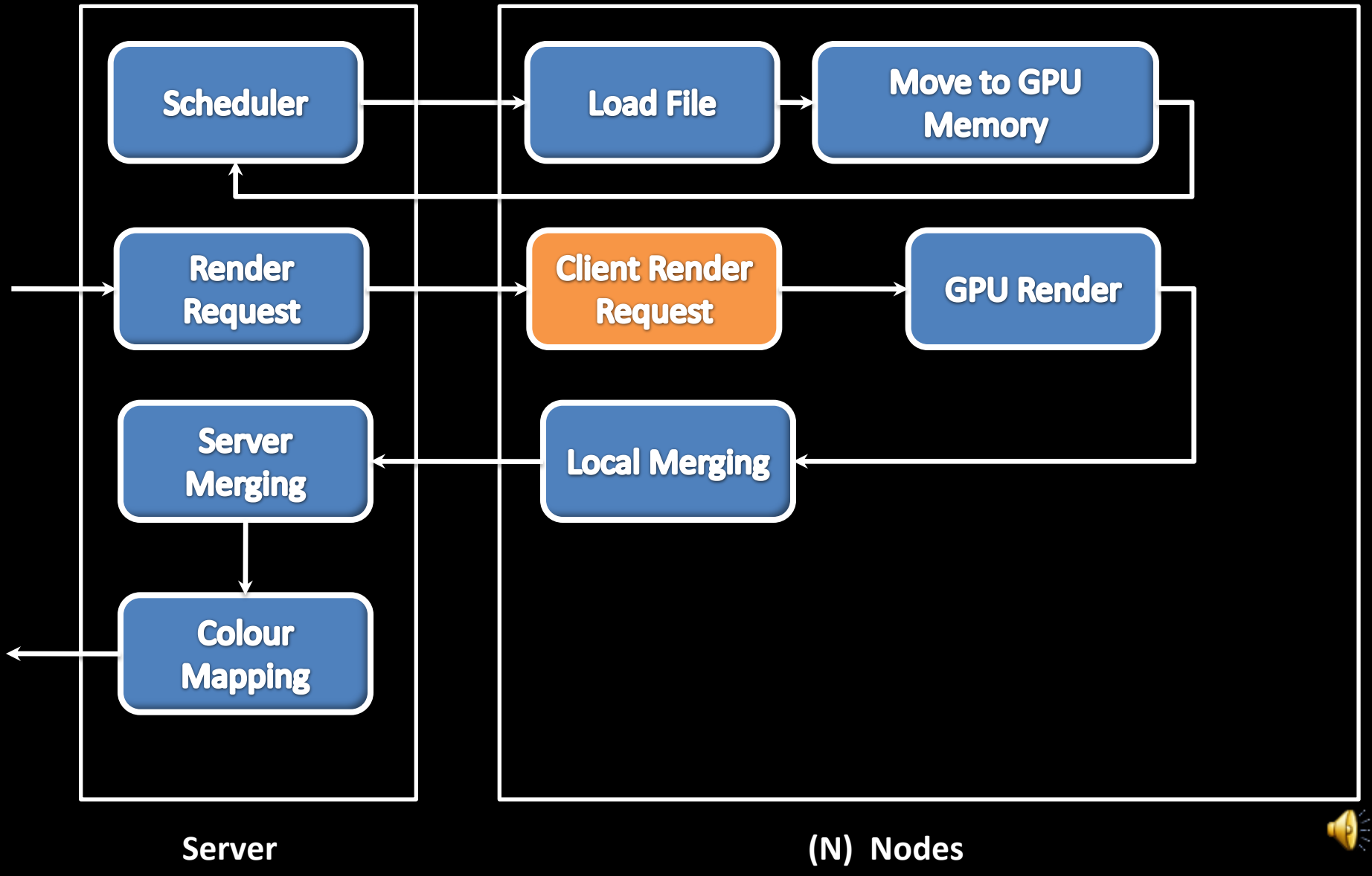
Framework Design



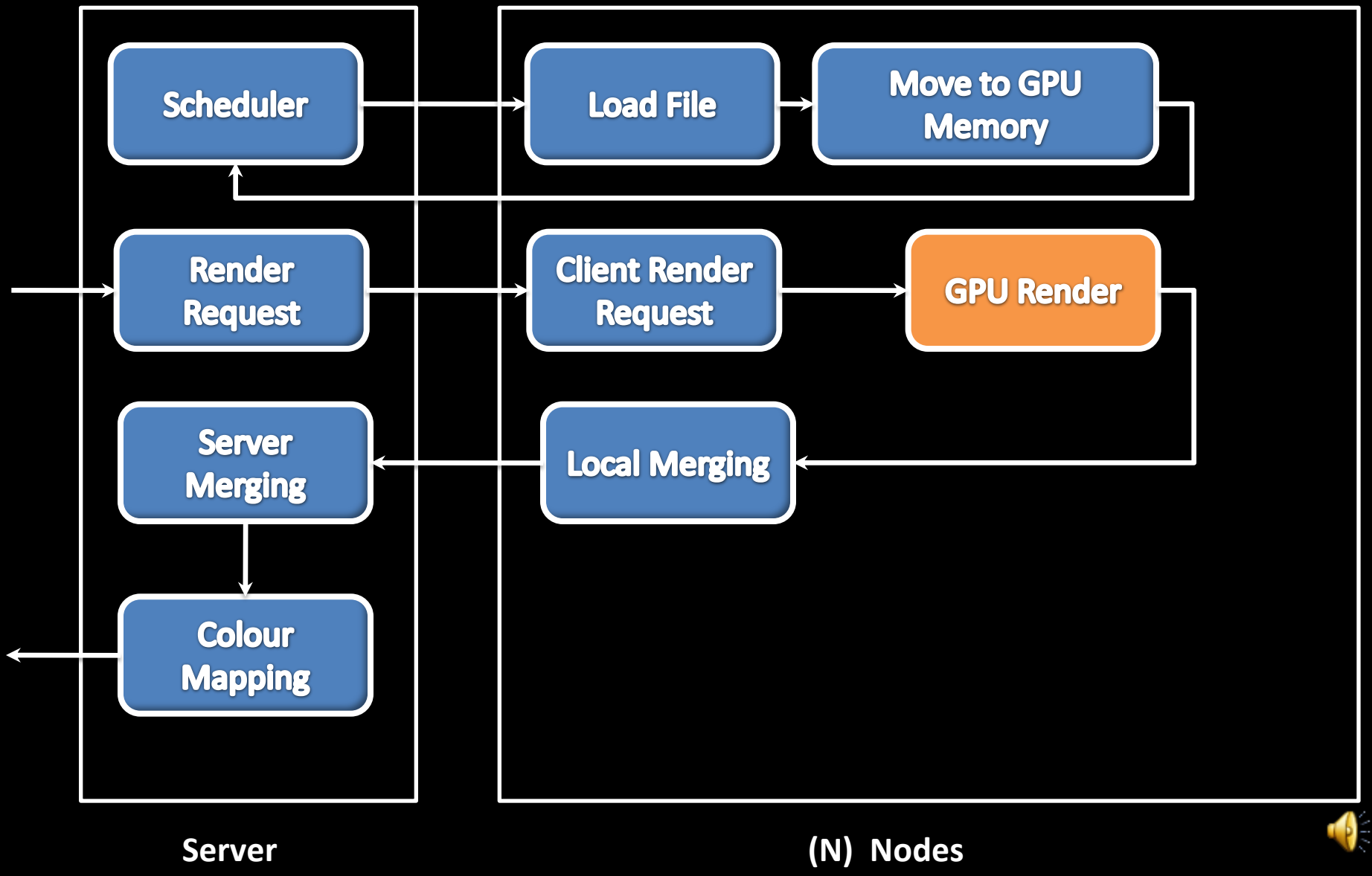
Framework Design



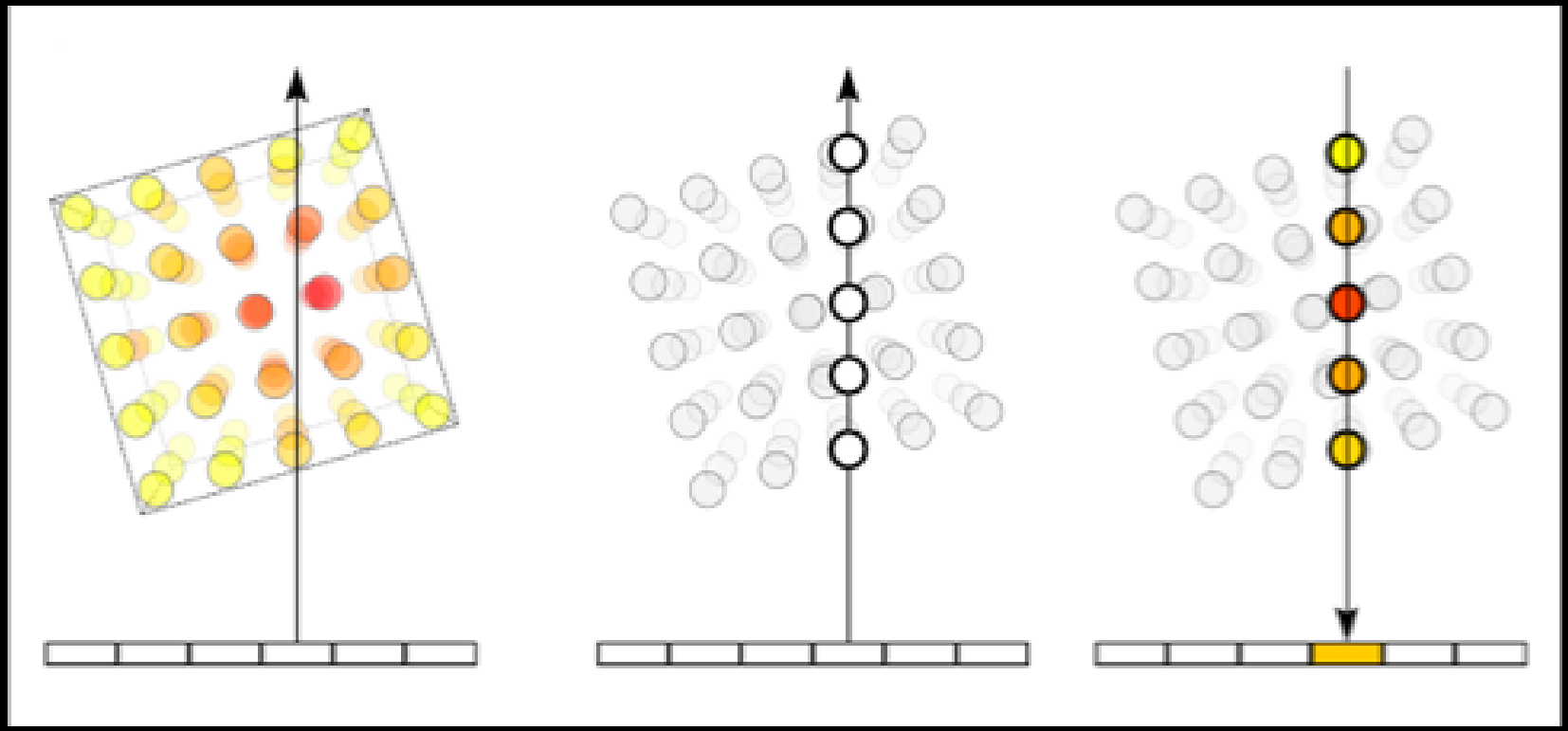
Framework Design



Framework Design

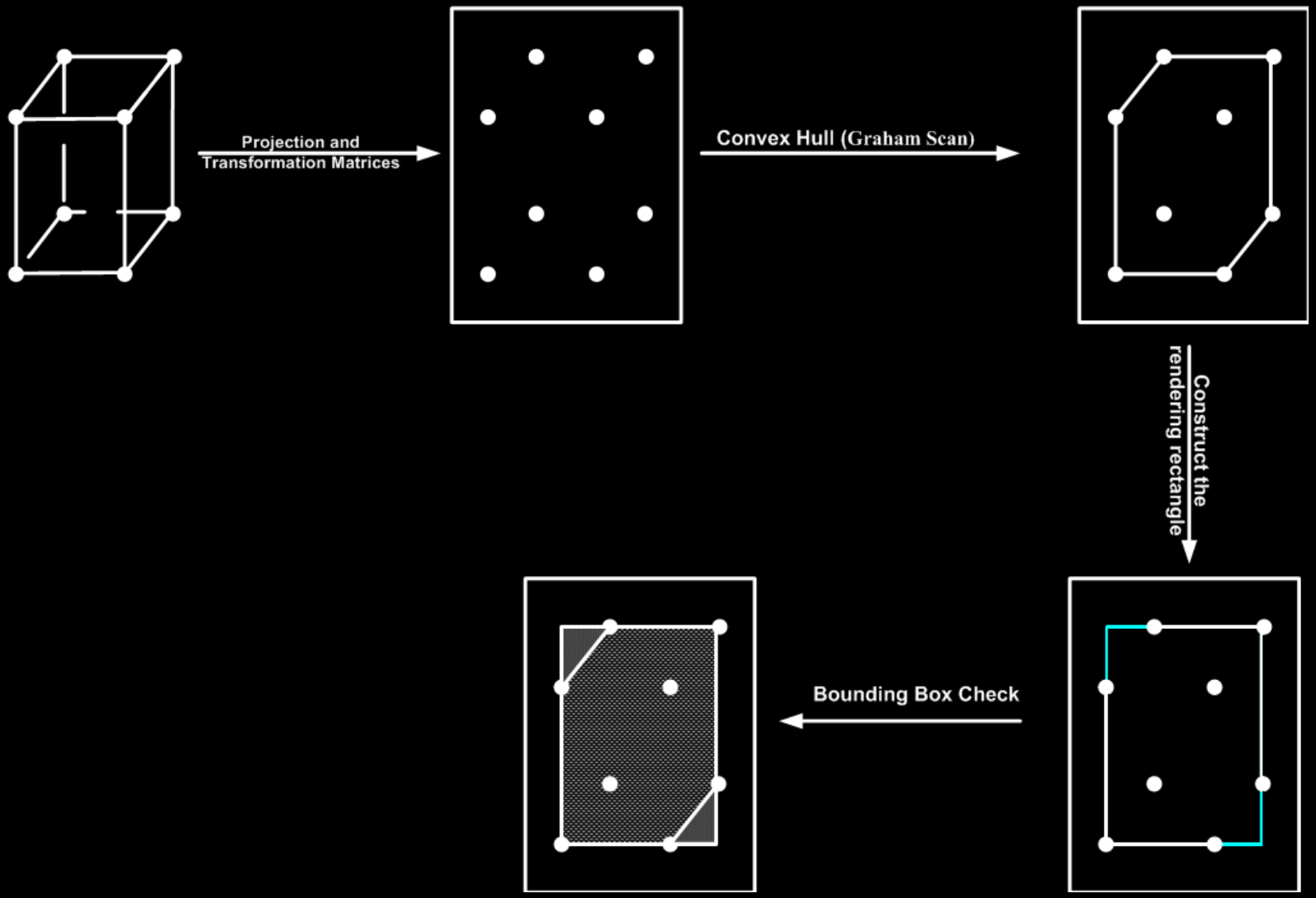


How Volume Rendering Ray-Casting works?

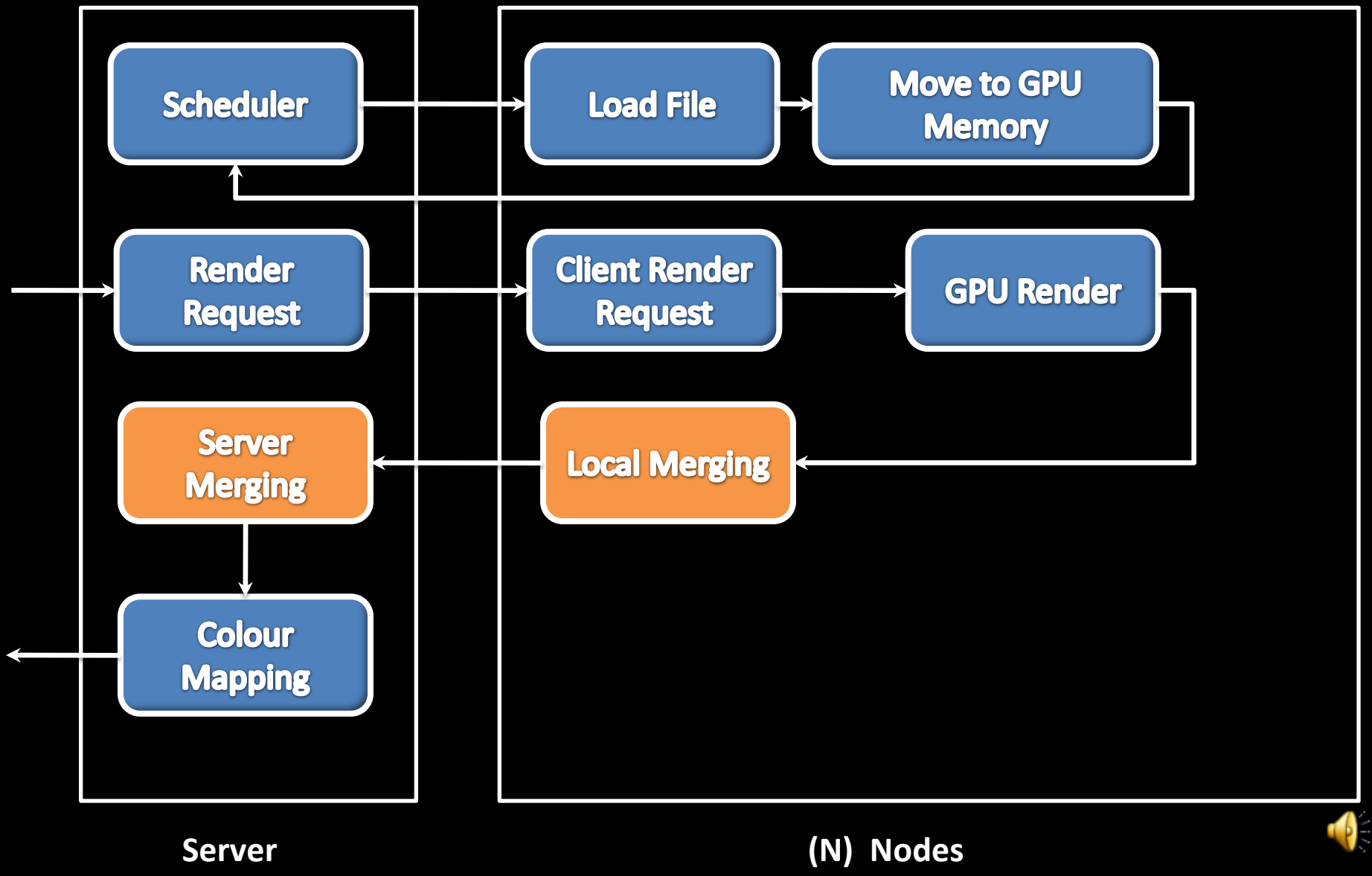


Volume Rendering using Graphics Hardware, Travis Gorkin
GPU Programming and Architecture, June 2009

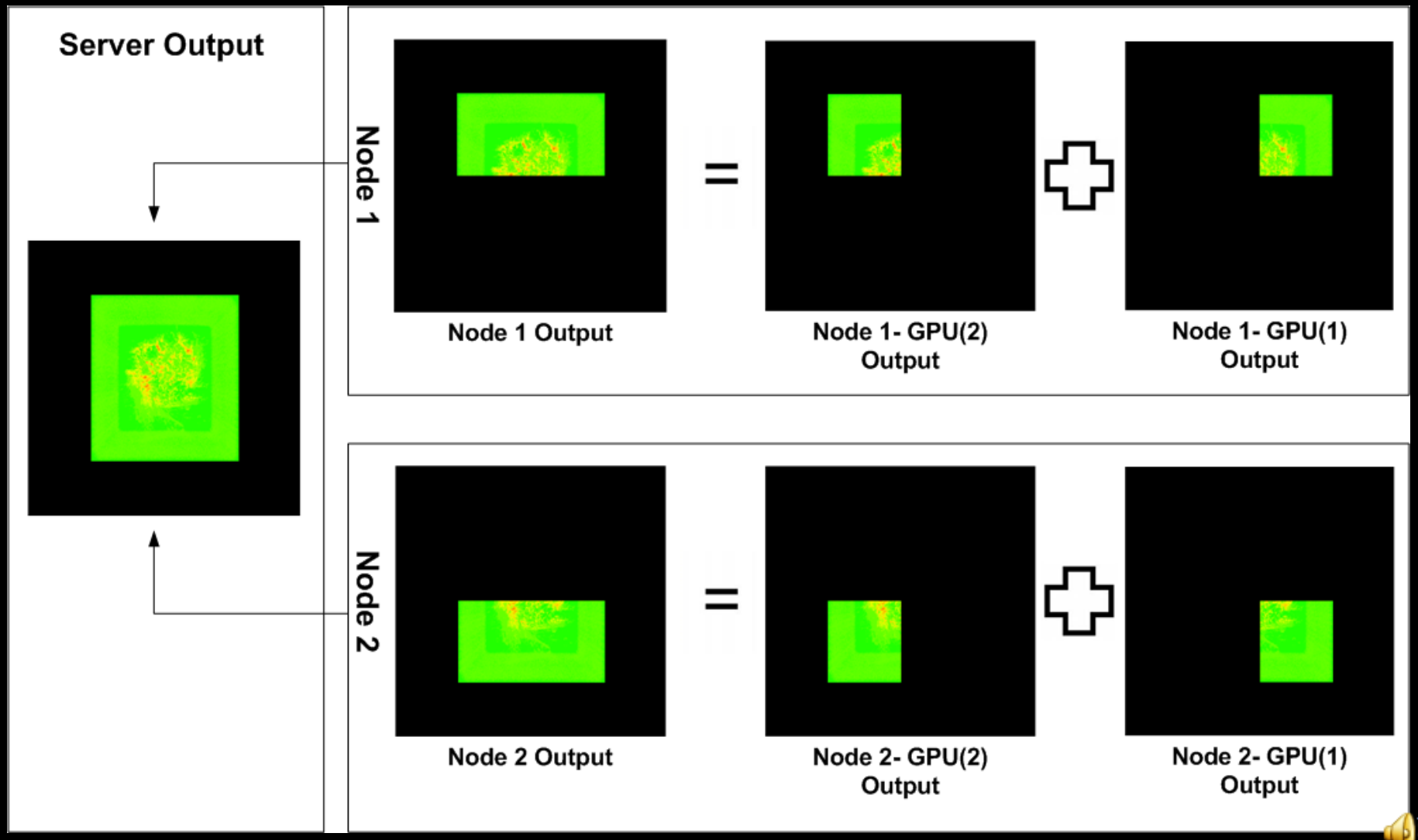
Rendering Rectangle
Using 2D Projection + Convex Hull



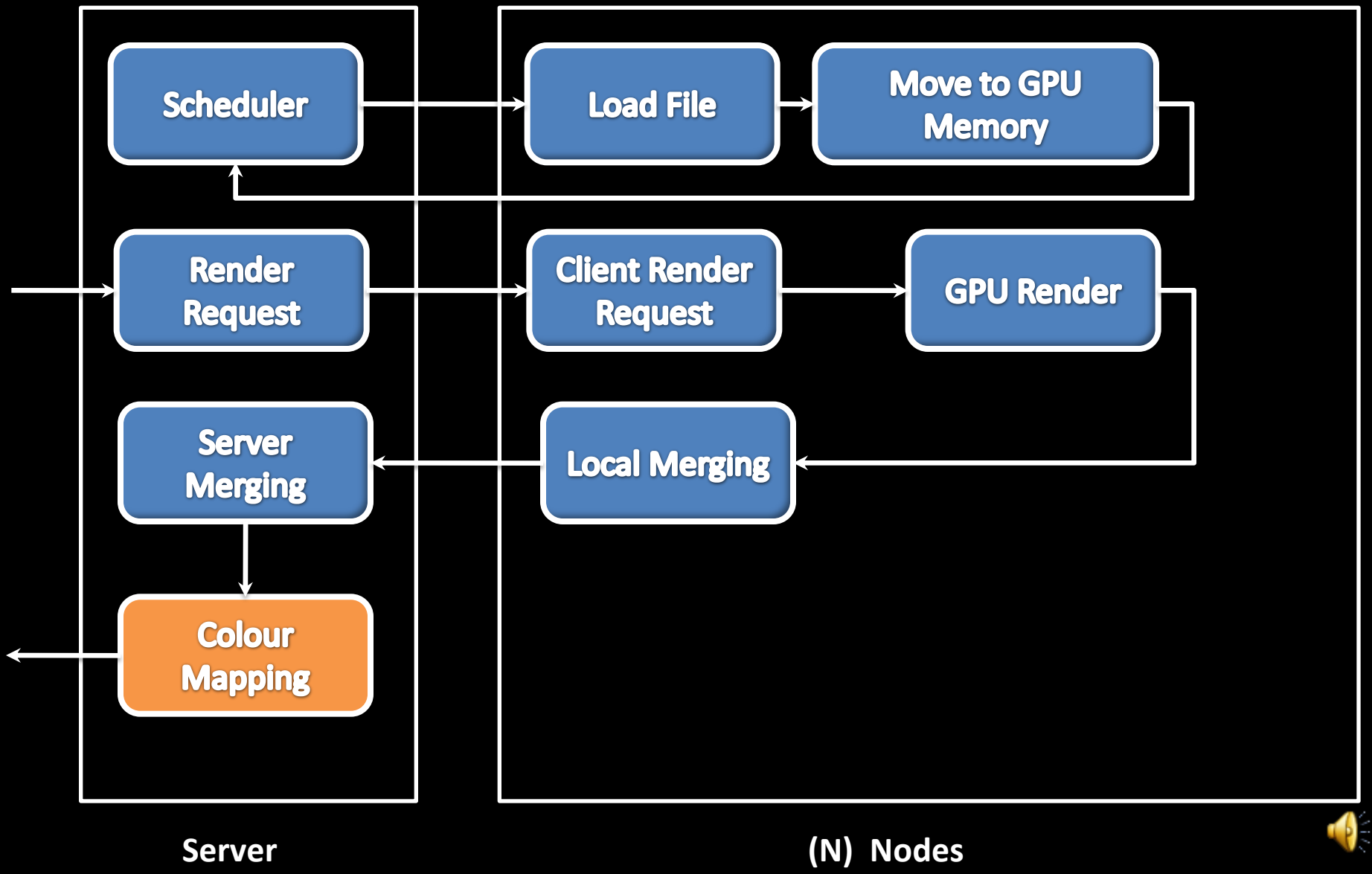
Framework Design



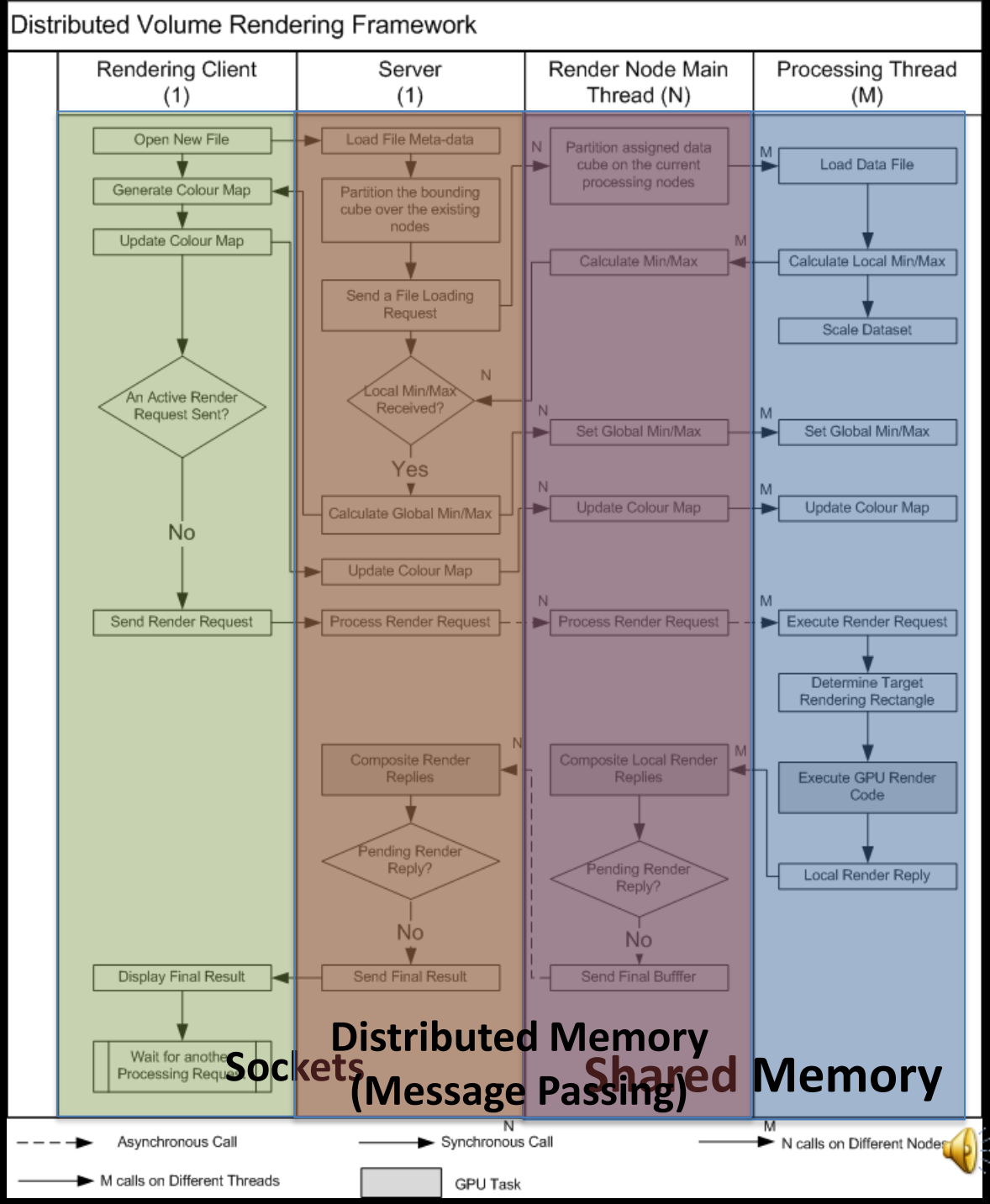
Rendering Rectangle



Framework Design



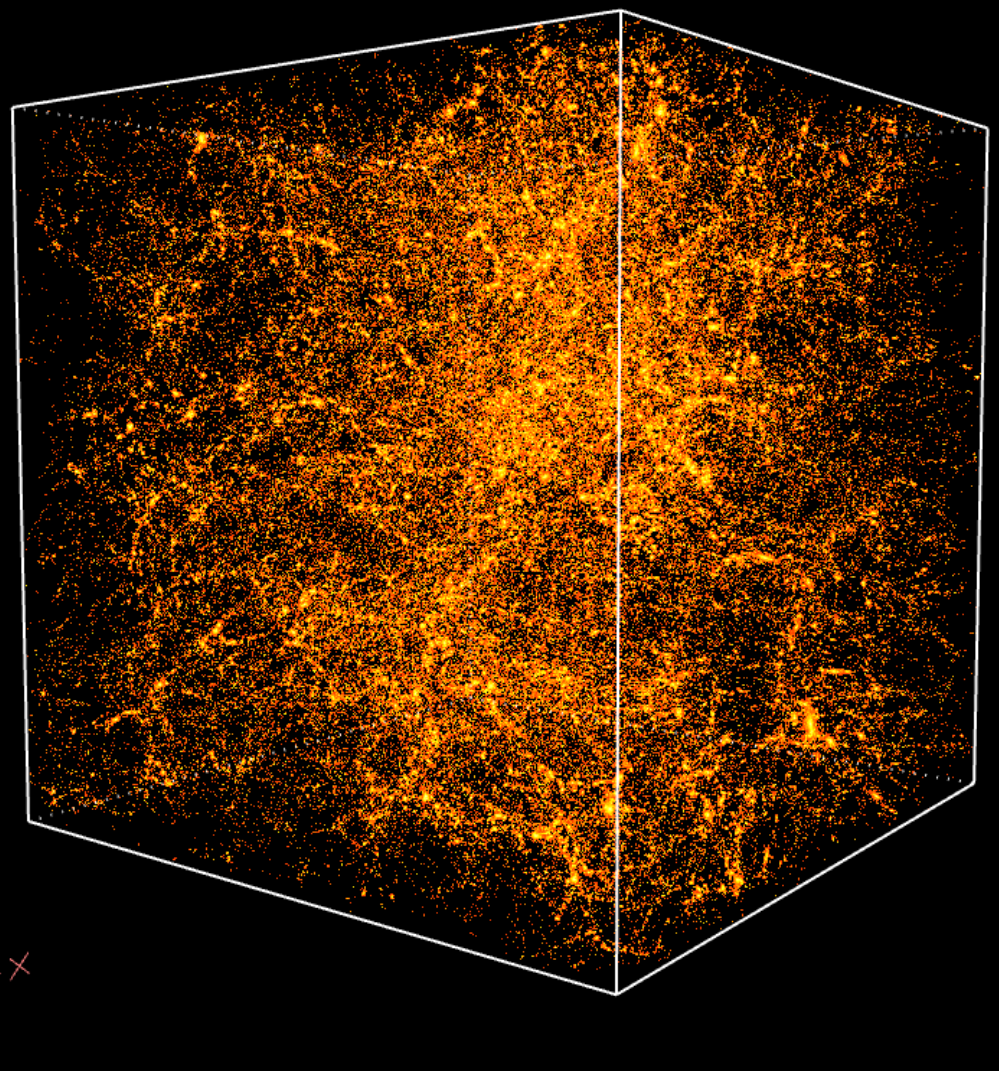
- Message Passing Interface
- Multi-Threading (QT)
- Custom Message Queue
- TCP Socket (QT)
- CUDA Driver API (3.1)
- OpenGL



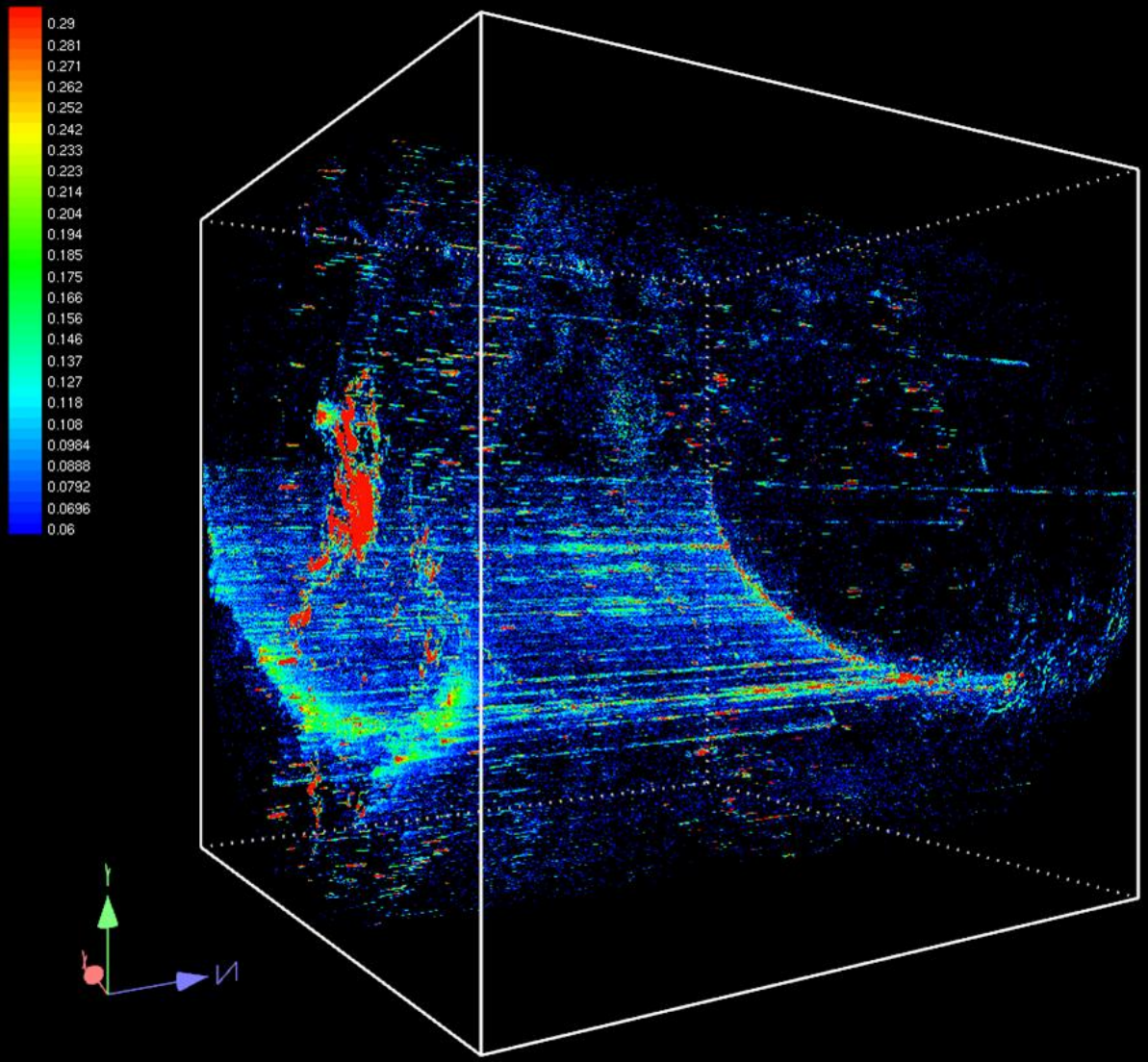
SCALABILITY AND PERFORMANCE ANALYSES

CSIRO GPU Cluster

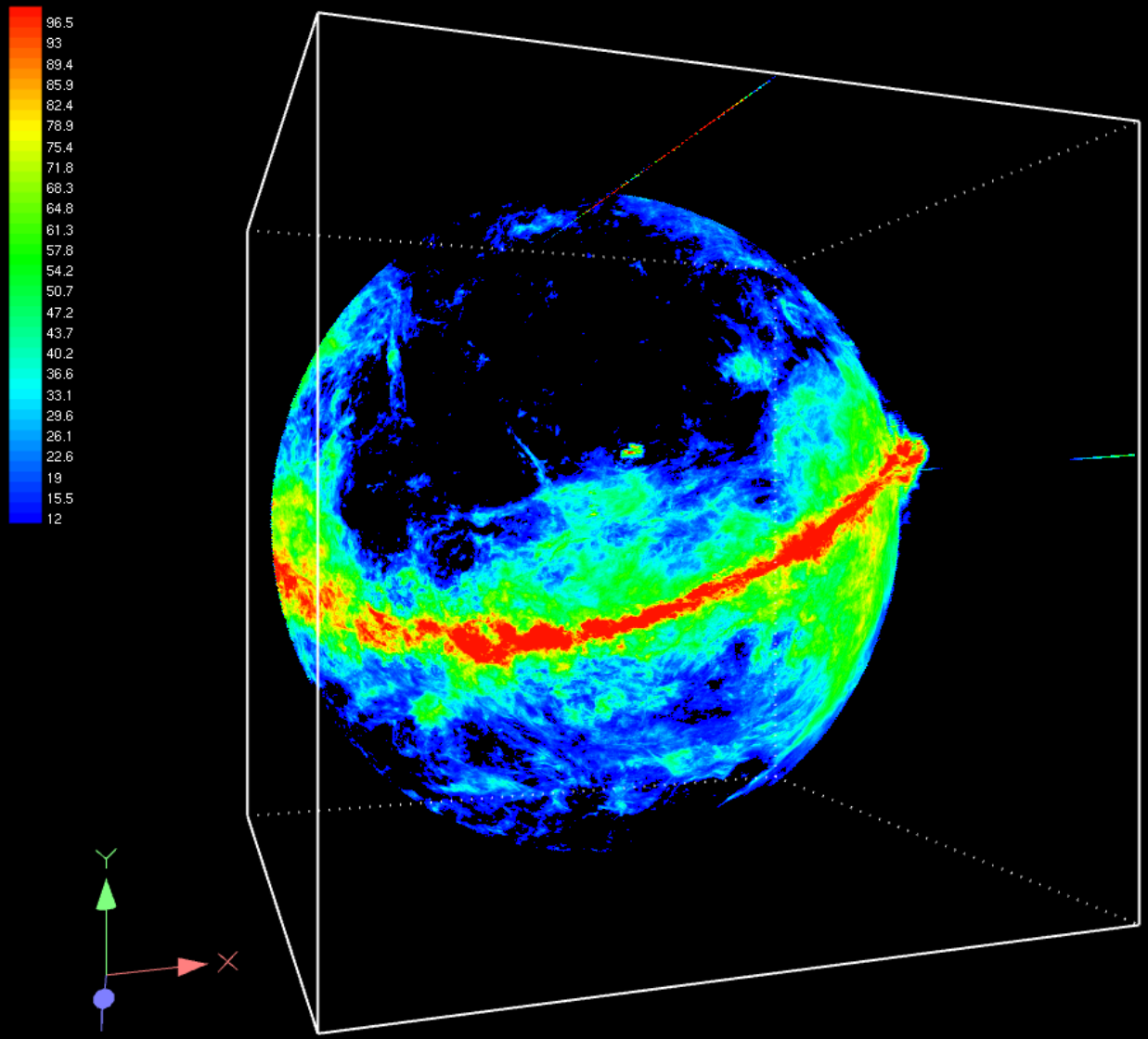
- 128 Dual Xeon E5462 Compute Nodes (With 8 2.8GHz compute cores each) with 16 GB or 32 GB of RAM, 500 GB SATA storage and DDR InfiniBand interconnect.
- 2 Tesla S2050s with each Node.
- 144 port DDR InfiniBand Switch.
- 80 Terabyte Hitachi NAS file system.
- Thanks to our collaboration with **Prof. Tim Cornwell and Dr. John A Taylor**.



Nbody Cube, Dark matter simulation of a 125 Mpc/h box, WiggleZ (SCWiggleZ) project
Data courtesy **Gregory Poole** ,
1024 x 1024 x 1024 = 4 GB
2600 x 2600 x 2600 = 66 GB

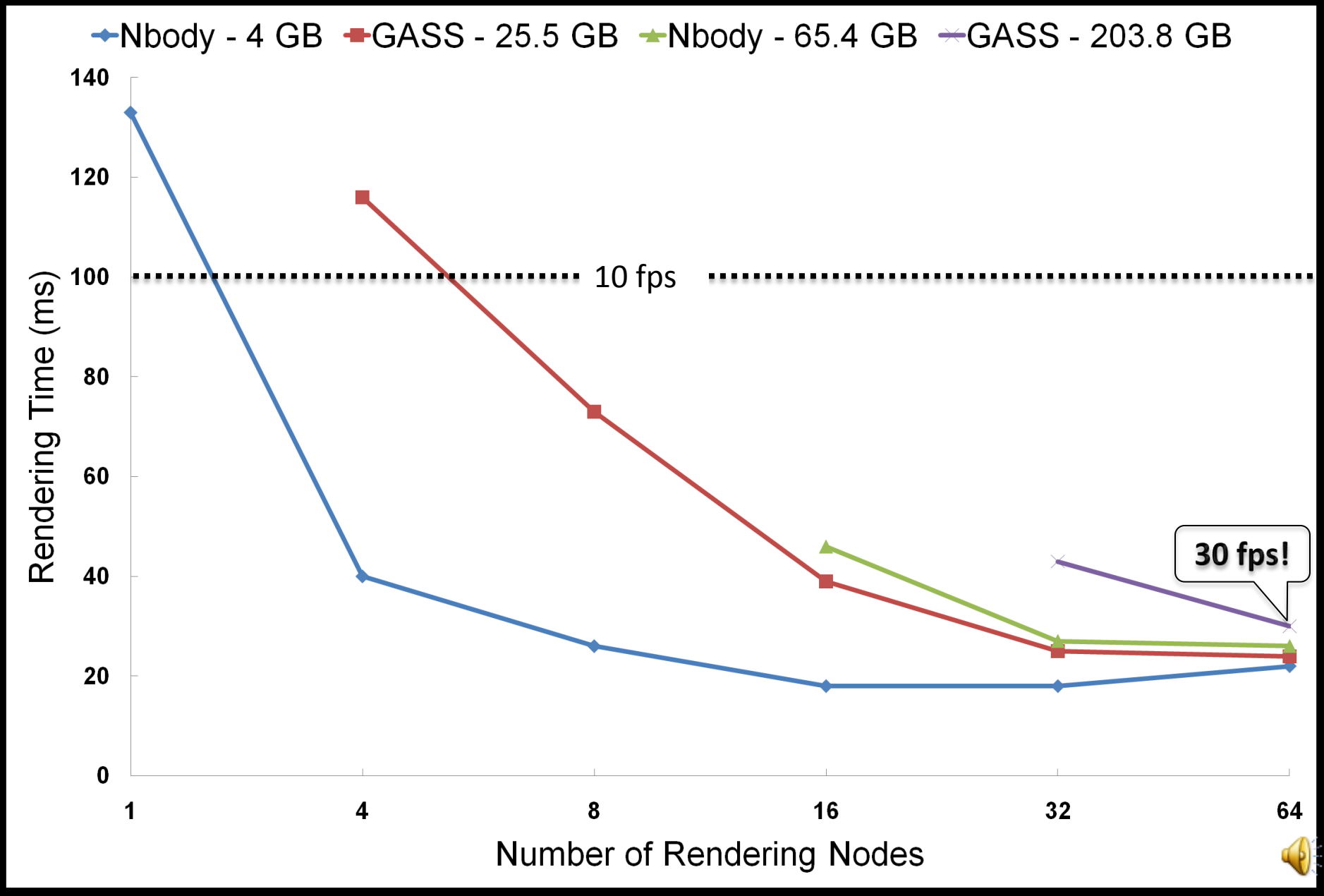


HIPASS Cube - HIPASS Southern Sky,
Data courtesy **Russell Jurek/HIPASS team**,
1721 x 1721 x 1025 = 12 GB

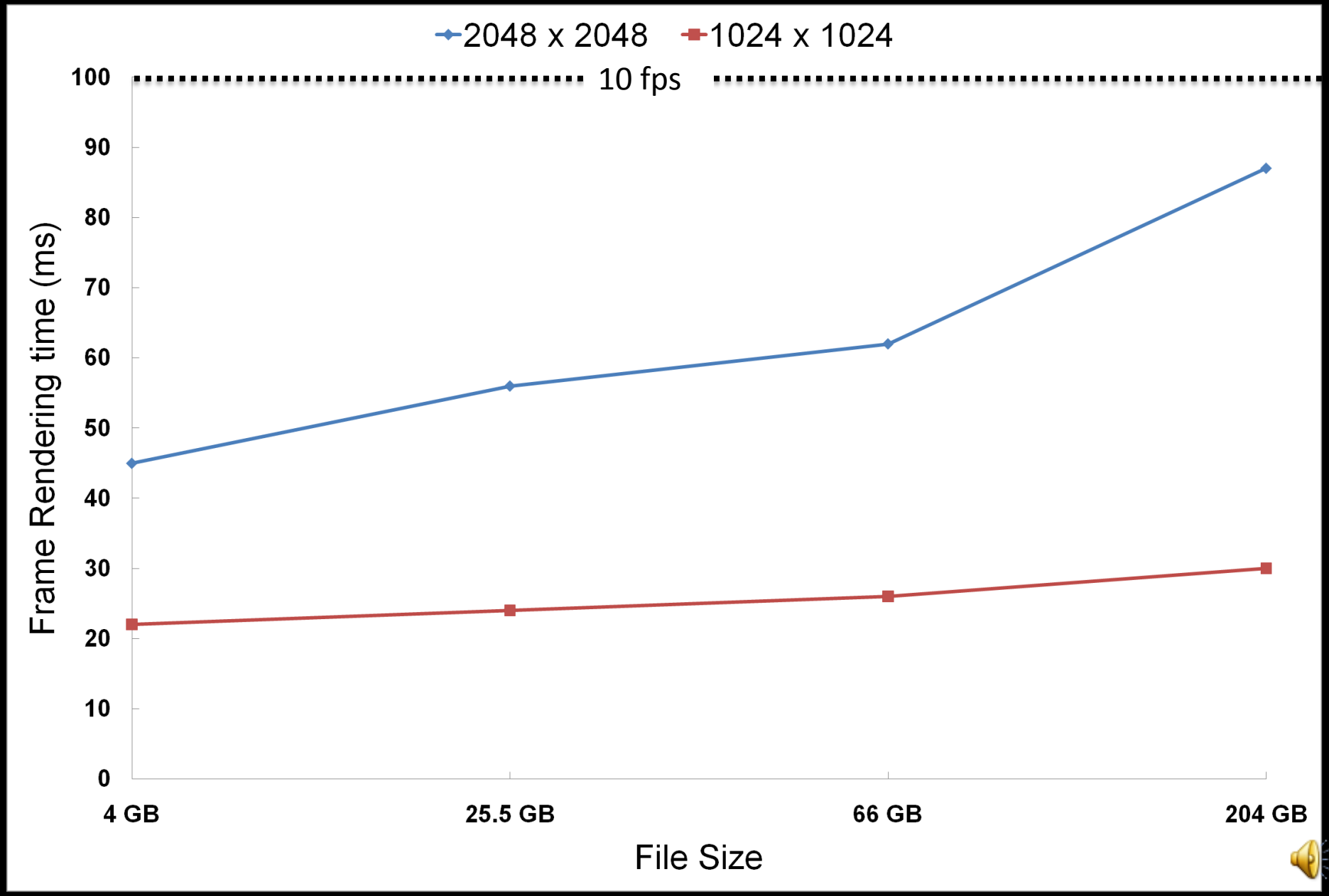


GASS Cube - The Parkes Galactic All-Sky Survey,
Data courtesy **Naomi McClure-Griffiths/ GASS team**
2502 x 2501 x 1093 = 25.5 GB
5004 x 5002 x 2186 = 204 GB

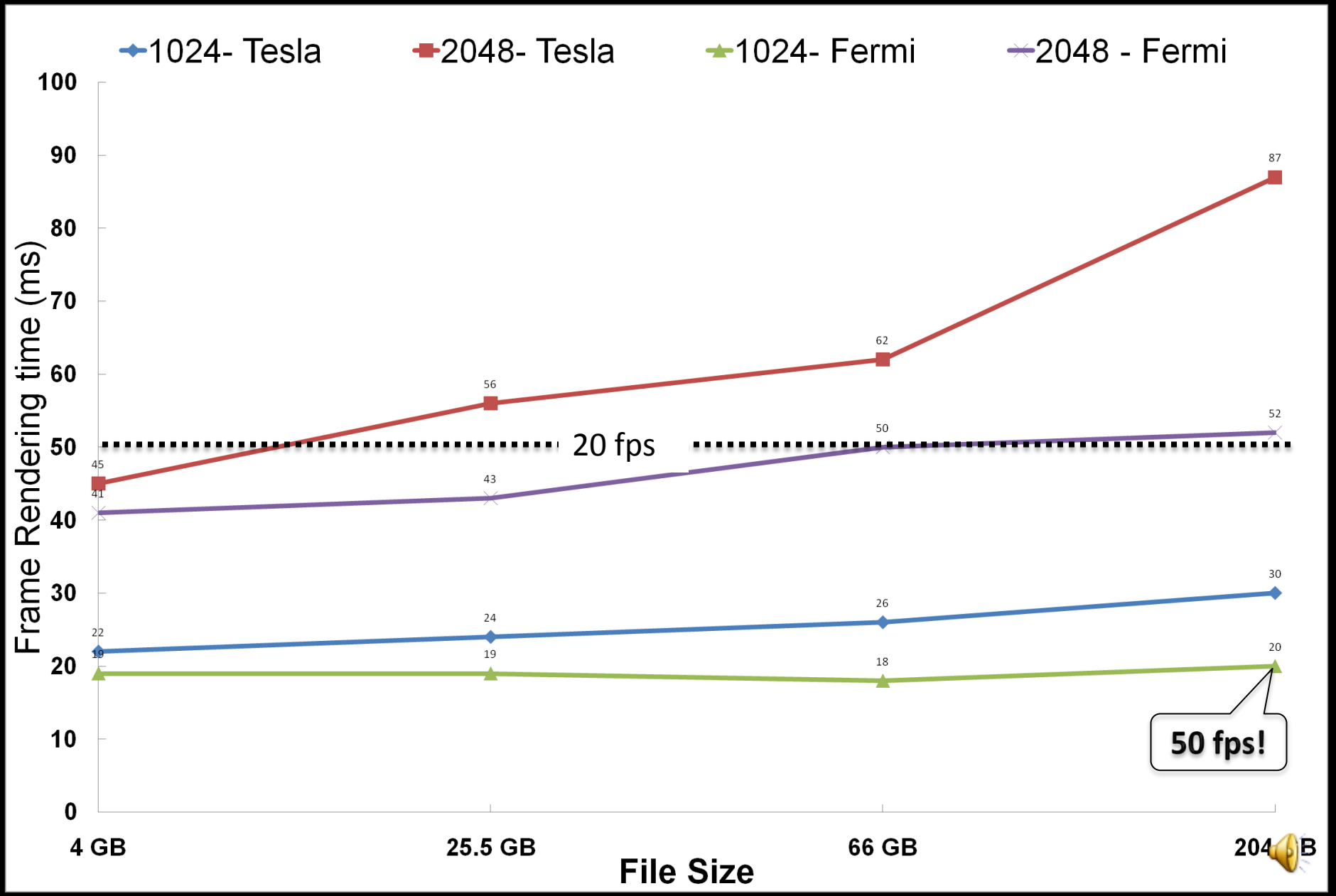
75% Percentile For All The Test Cubes



75% Percentile For All The Test Cubes – 64 Nodes – Different Output Resolutions

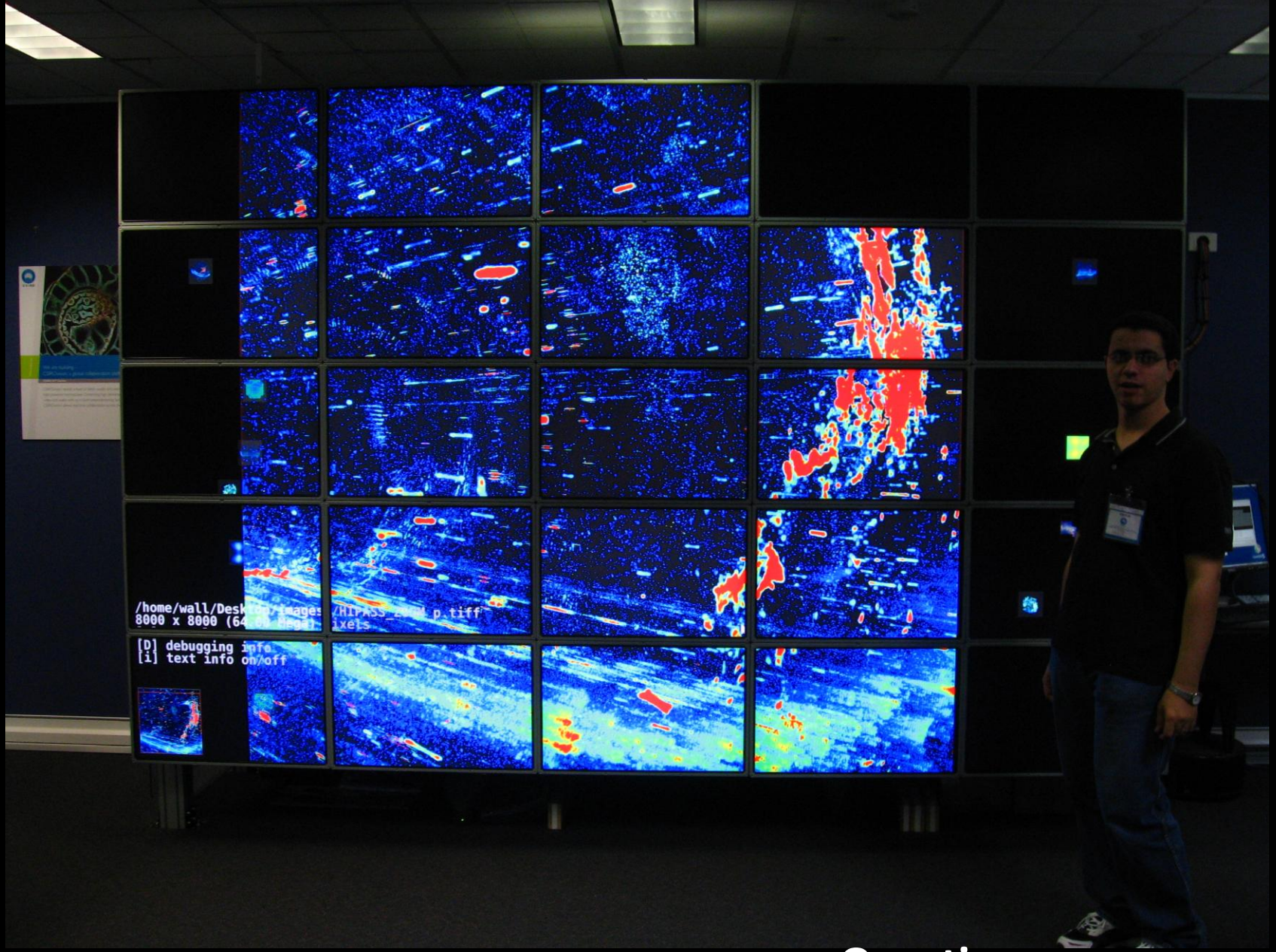


75% Percentile For All The Test Cubes – 64 Nodes – Different Output Resolutions
Fermi Vs. Tesla



Conclusions

- We design and implement a framework to interactively visualize larger-than-memory spectral data cubes.
- Our framework uses GPU as the main computing element.
- We overcome the memory limitation of the GPU by using a distributed GPU infrastructure.



CSIRO Optiportal at Marsfield, NSW.
Credit: Dr. Christopher Fluke

Questions:
ahassan@swin.edu.au