A Scalable Hardware Architecture For Parallel Volume Rendering

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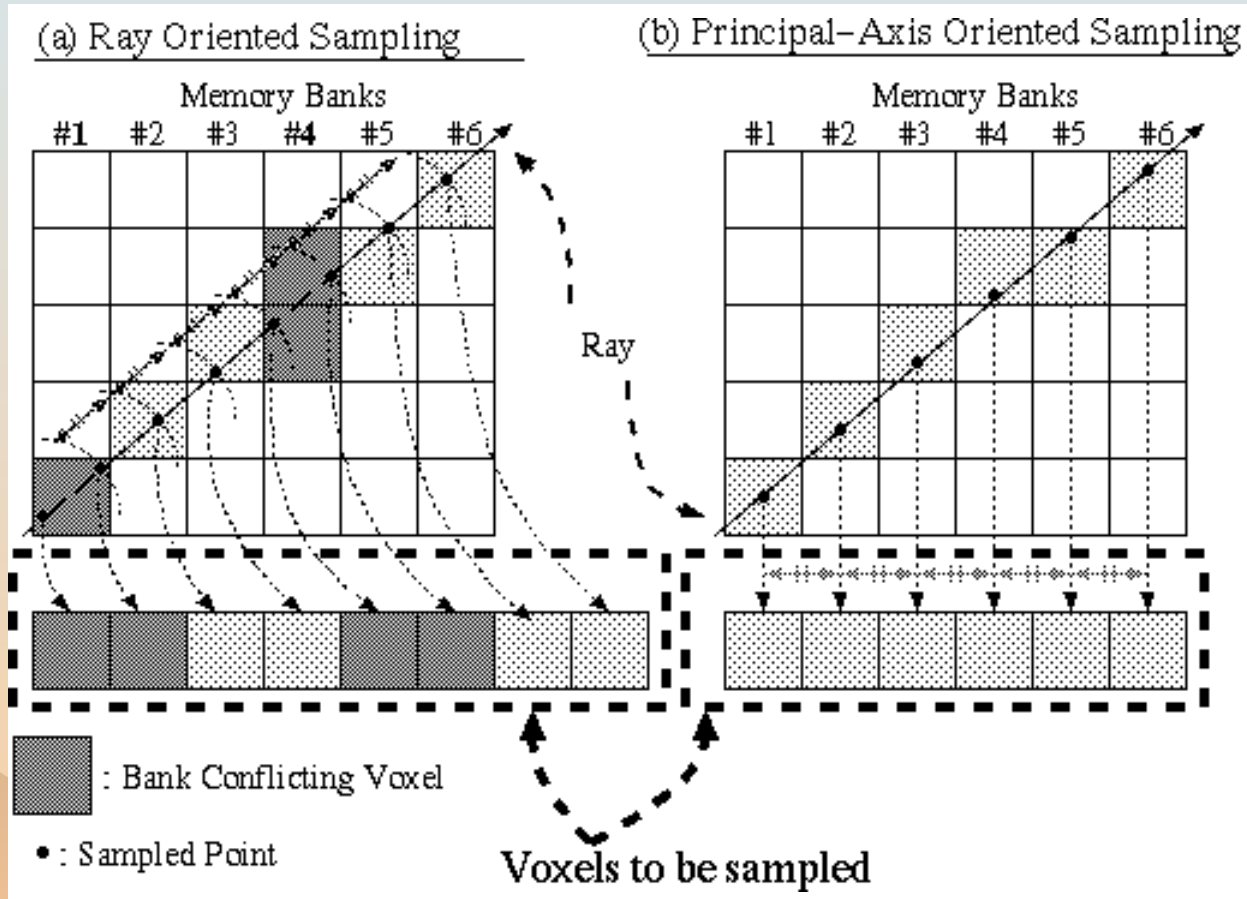
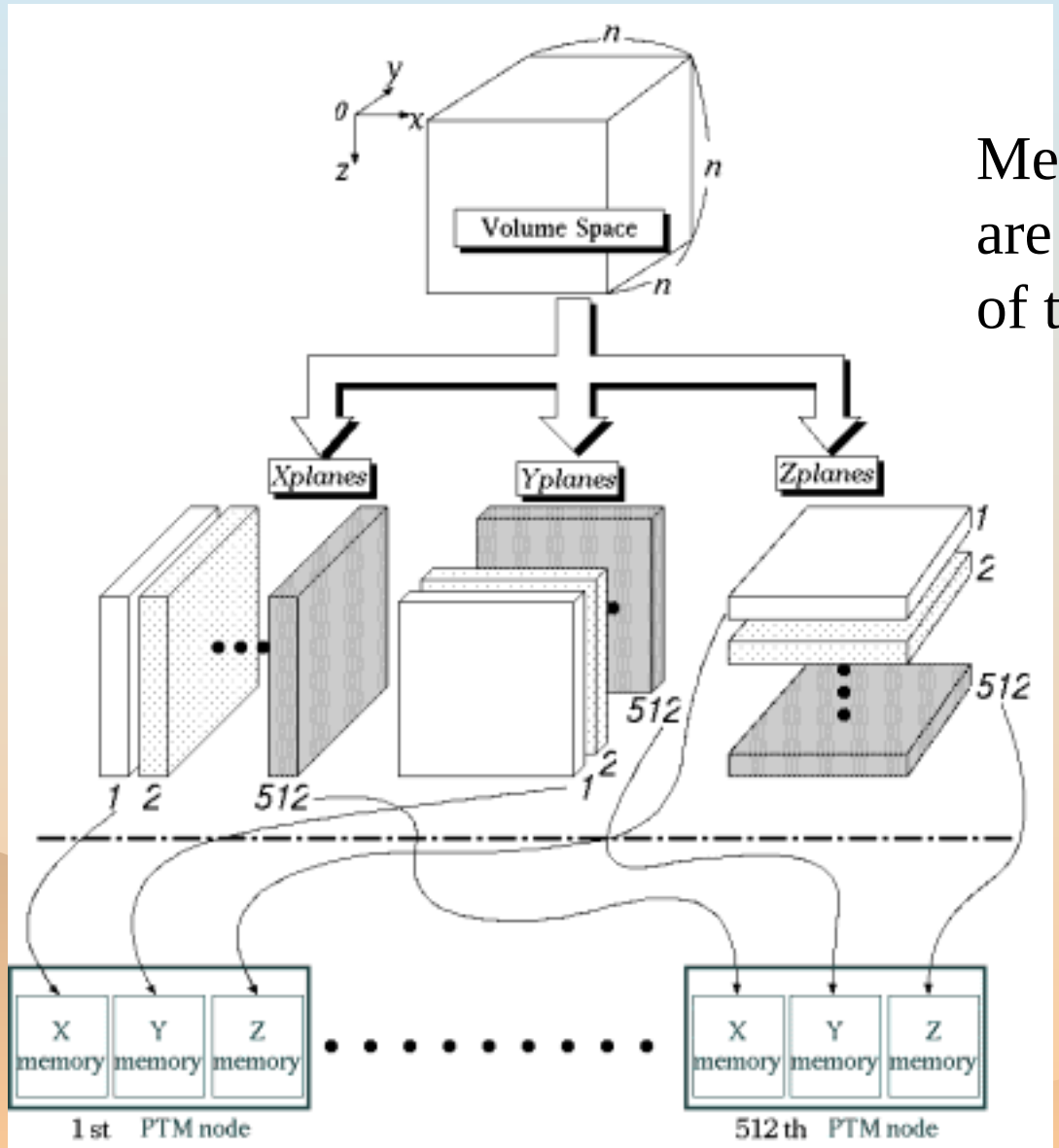
ReVolver/C40：A Prototype Implementation of the Parallel Volume Rendering Machine **ReVolver**

- Goals
  - Discrete and Continuous Models
  - Translucent Volumes
  - Perspective and Parallel Projections
  - Real-time Visualization of 128^3 volume
    - Near Real-time Visualization of 512^3 volume
  - Volume Ray Tracing

Conflict Free Sampling Method

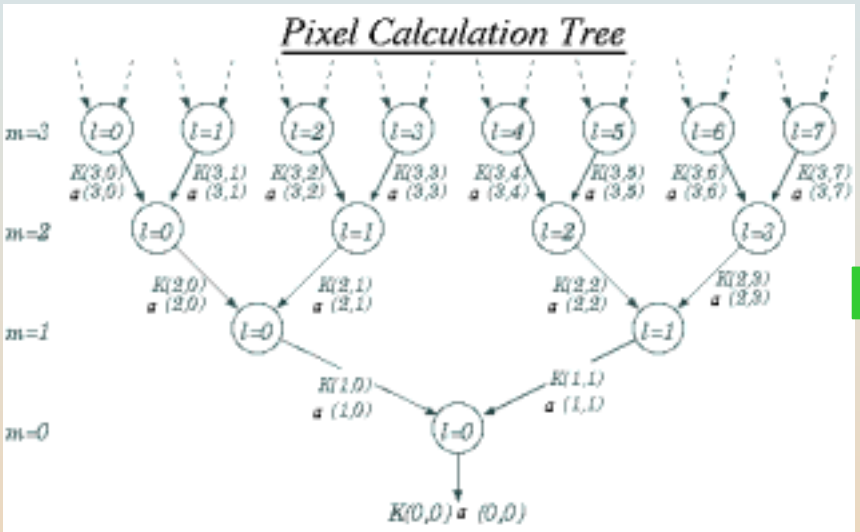


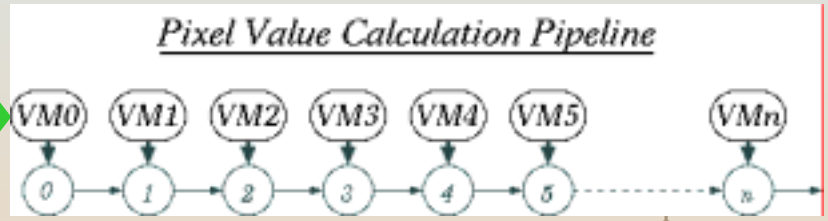
Parallel Treble Volume Memory



Memories of three time larger are more promising than those of three time faster!!

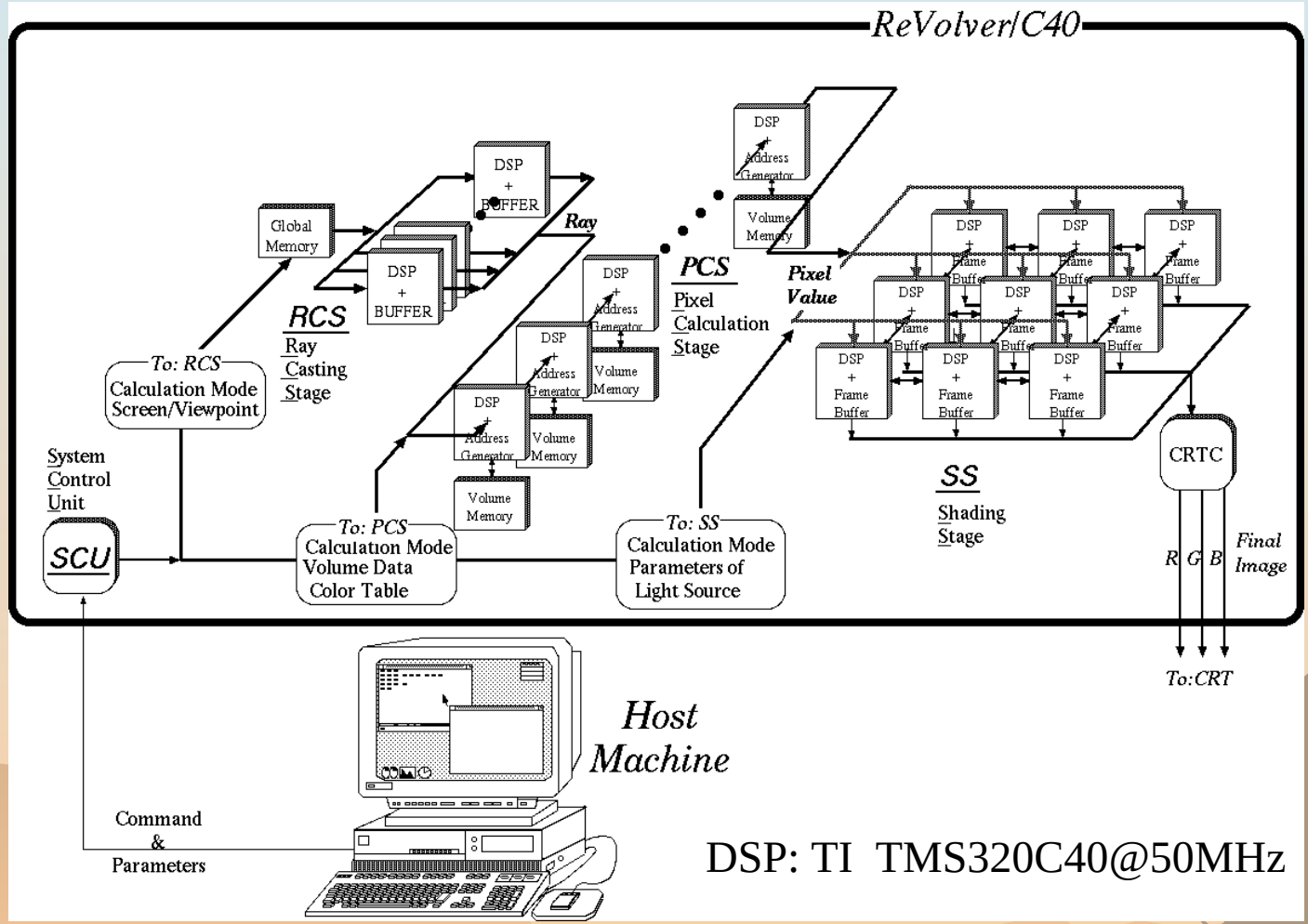
Simplification of the Composition Network



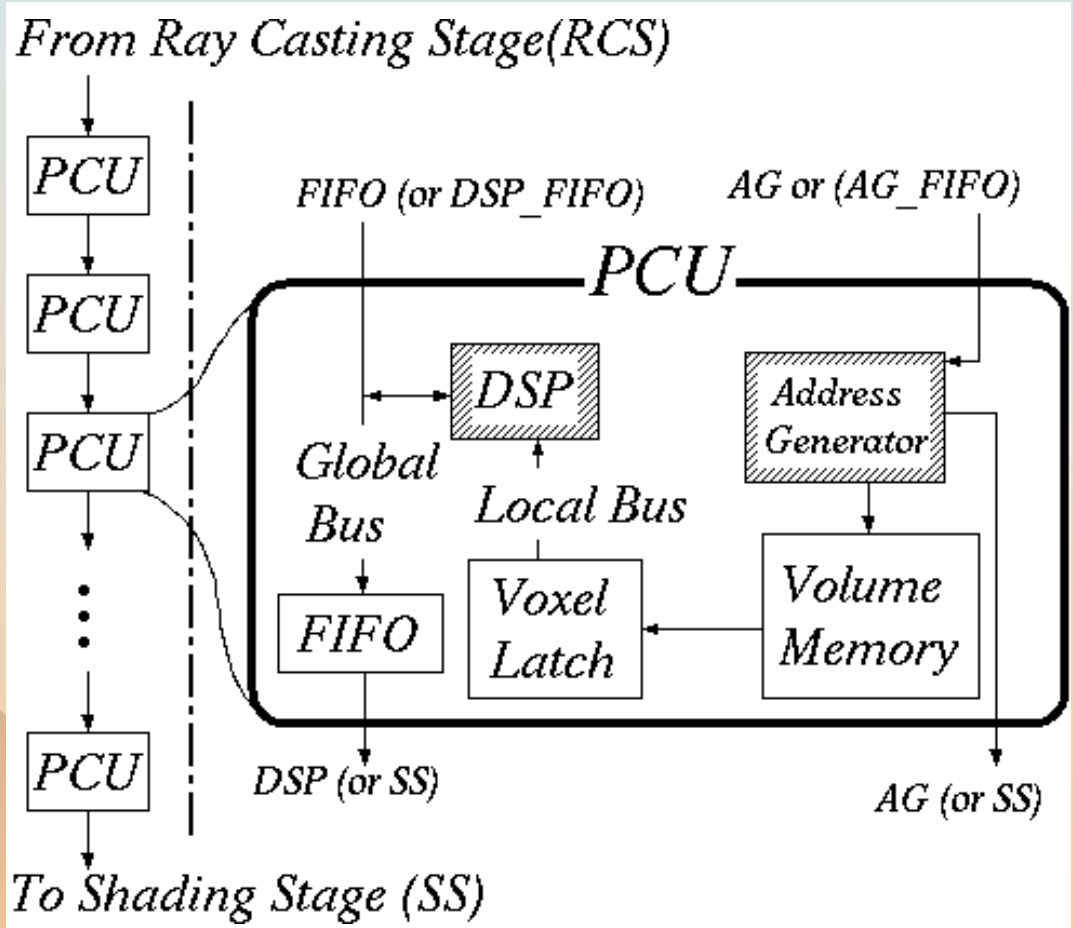


- Throughput — Unchanged
- Latency — Log N ⇒ N …. No problem for NxN screen
- HW Logic — Unchanged
- HW Wiring — 2N ⇒ N ….. Easier to Implement

Overview of the ReVolver/C40



PCS node:
General Purpose DSP with Voxel Preloading



- DSP:

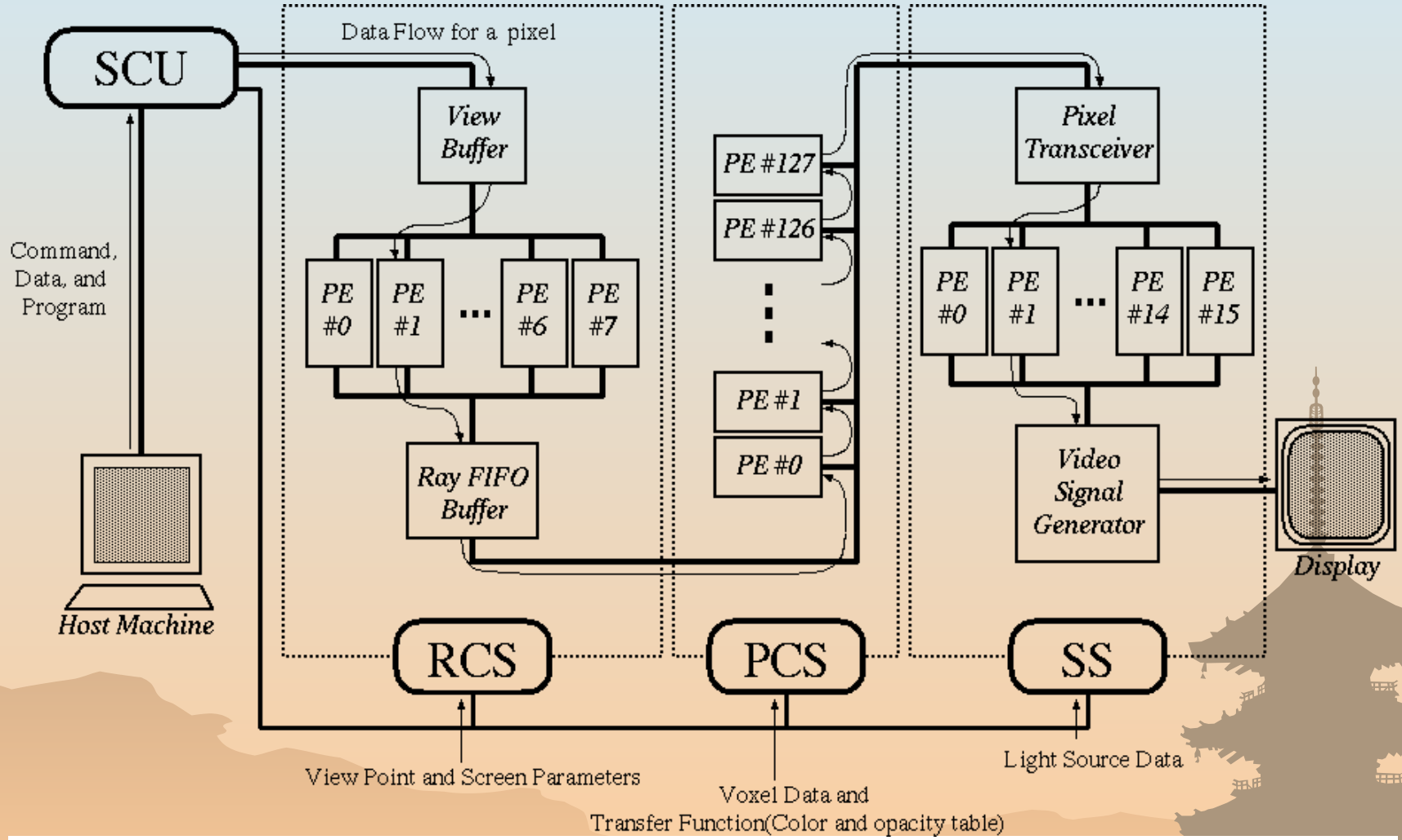
  TI TMS320C40@50MHz

  C& α LUT
- Volume Memory

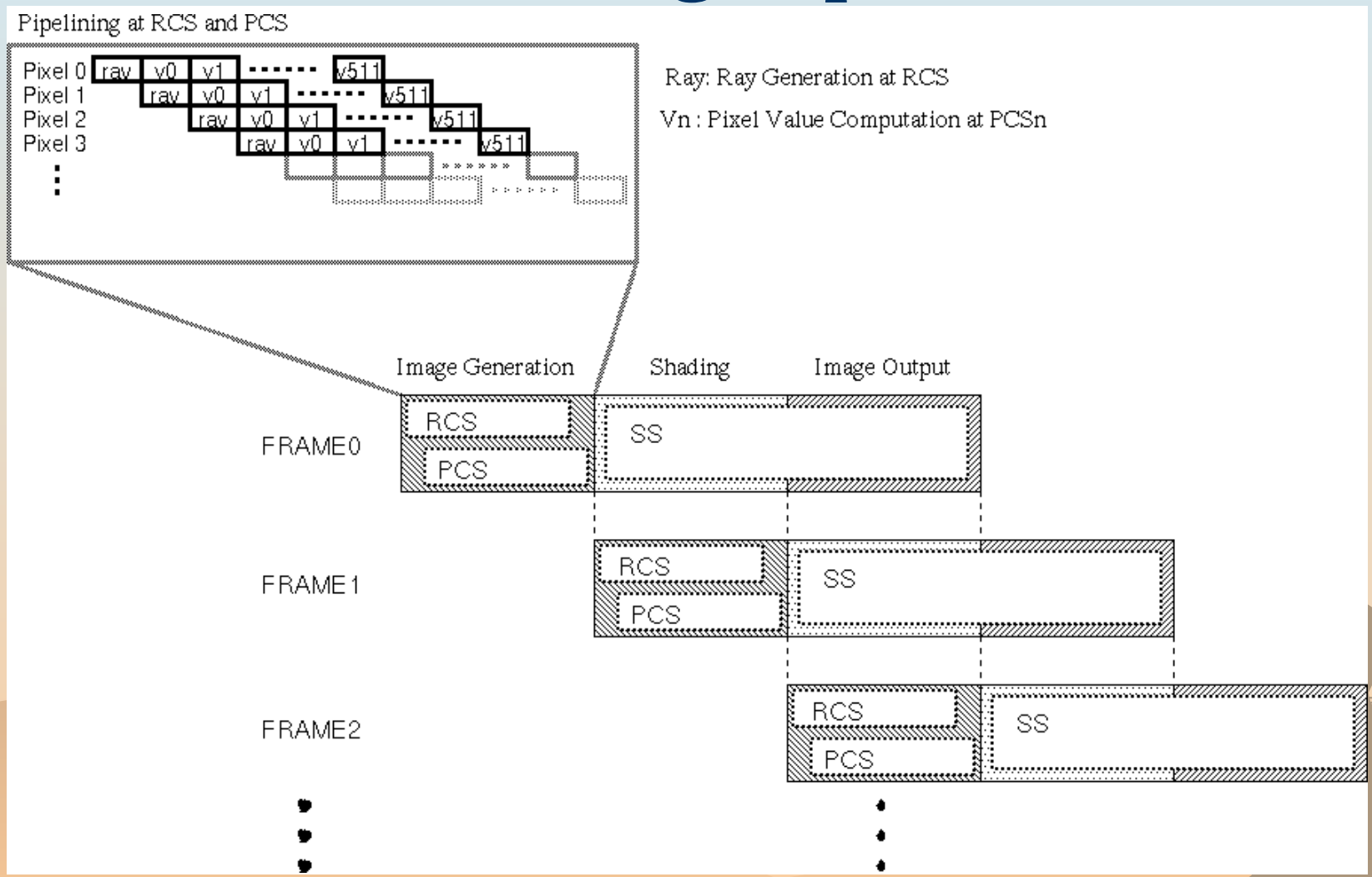
  …..Logically Tripled
- Address Generator

  for Voxel Preloading

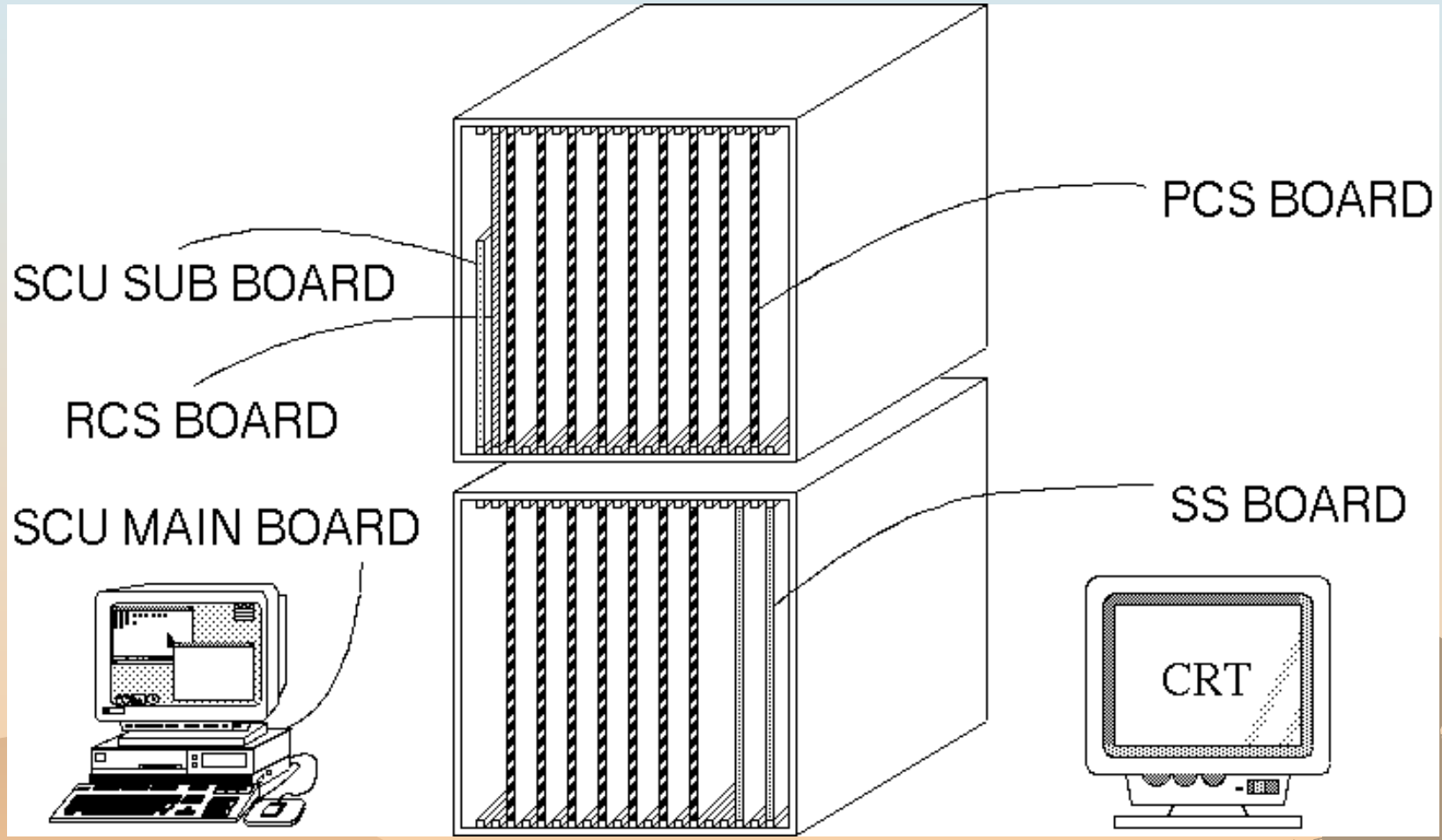
Data Flow on the ReVolver/C40



Rendering Pipeline



ReVolver/C40 Full System Image



RCS: 8DSPs, PCS:128DSPs, SS:16DSPs

Current Status

- ReVolver/C40-mini
  - RCS:3DSPs, PCS:8DSPs w Voxel Preload, SS:8DSPs
- ReVolver/C40-demo
  - RCS: none, PCS:32DSPs w/o Voxel Preload, SS:8DSPs

Preliminary Performance Evaluation(I)

- ReVolver/C40-mini
  - RCS:3DSPs, PCS:8DSPs w Voxel Preload, SS:8DSPs
    - 128x128 Screen
      - 80ms (8^3 Volume), 94ms(16^3 Volume), 136ms(32^3Volume)

Estimation for full system organization

128^3 Volume, 128x128 Screen ……80ms/frame

256^3 Volume, 256x256 Screen ……374ms/frame

512^3 Volume, 512x512 Screen …..2173ms/frame

Preliminary Performance Evaluation(II)

- ReVolver/C40-demo
  - RCS: none, PCS:32DSPs w/o Voxel Preload, SS:8DSPs
    - 256x256 Screen
      - 0.29frames/s for 256^3 Volume …… 8times overloading

Estimation for 256^3 Volume

- ✧Standard Loading ……. 2.37 frames/s
- ✧With Voxel Preload …… 5.97 frames/s

Future Plans

- Large Data Visualization
  - 2048^3 Volume 1280x1024 Screen
- Active Rendering
  - Simulation & Simultaneous Visualization
- Simulation Steering with Active Rendering