
# Multi-Core/Player Game Loops

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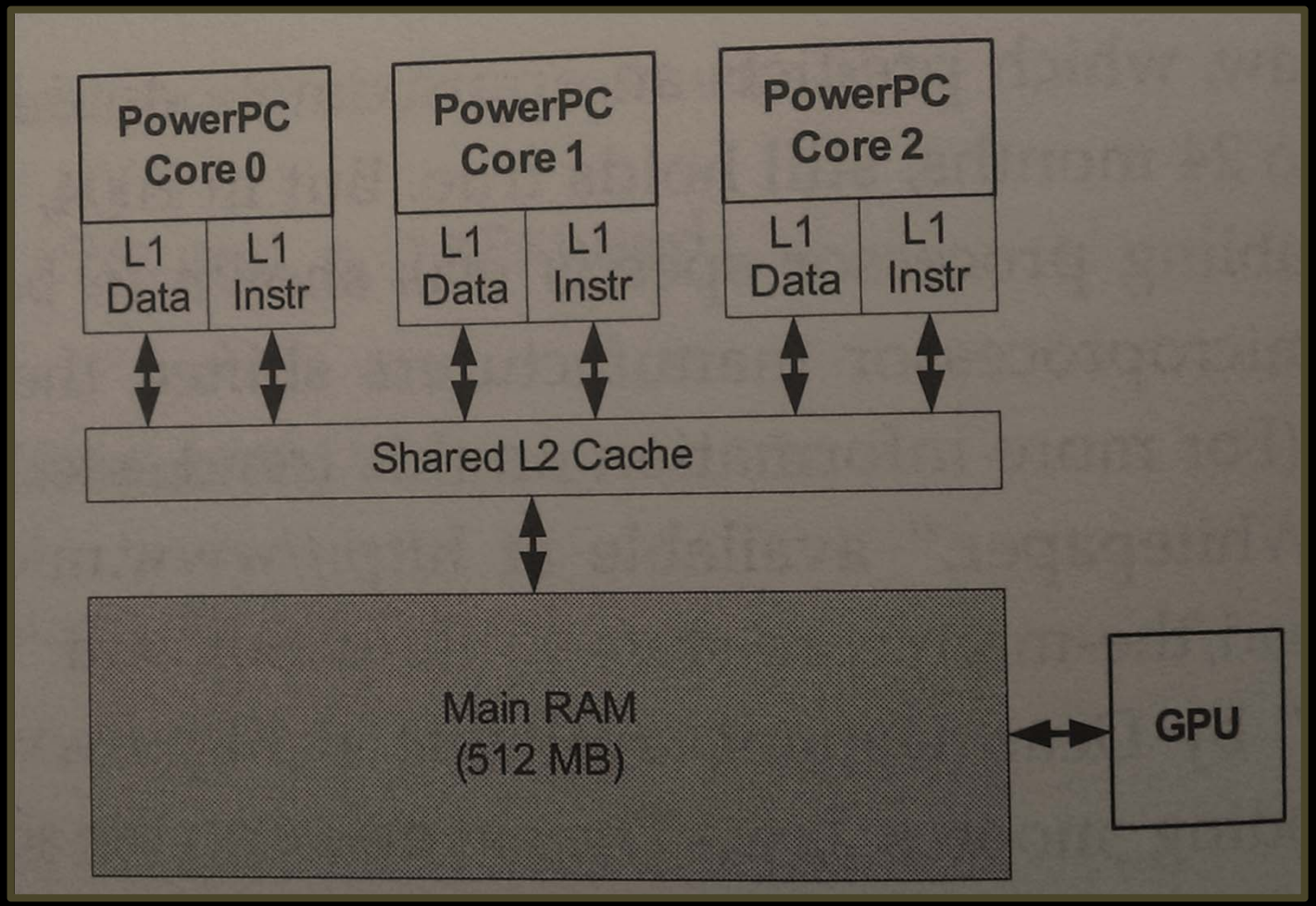
# Multi-Processor Game Loops

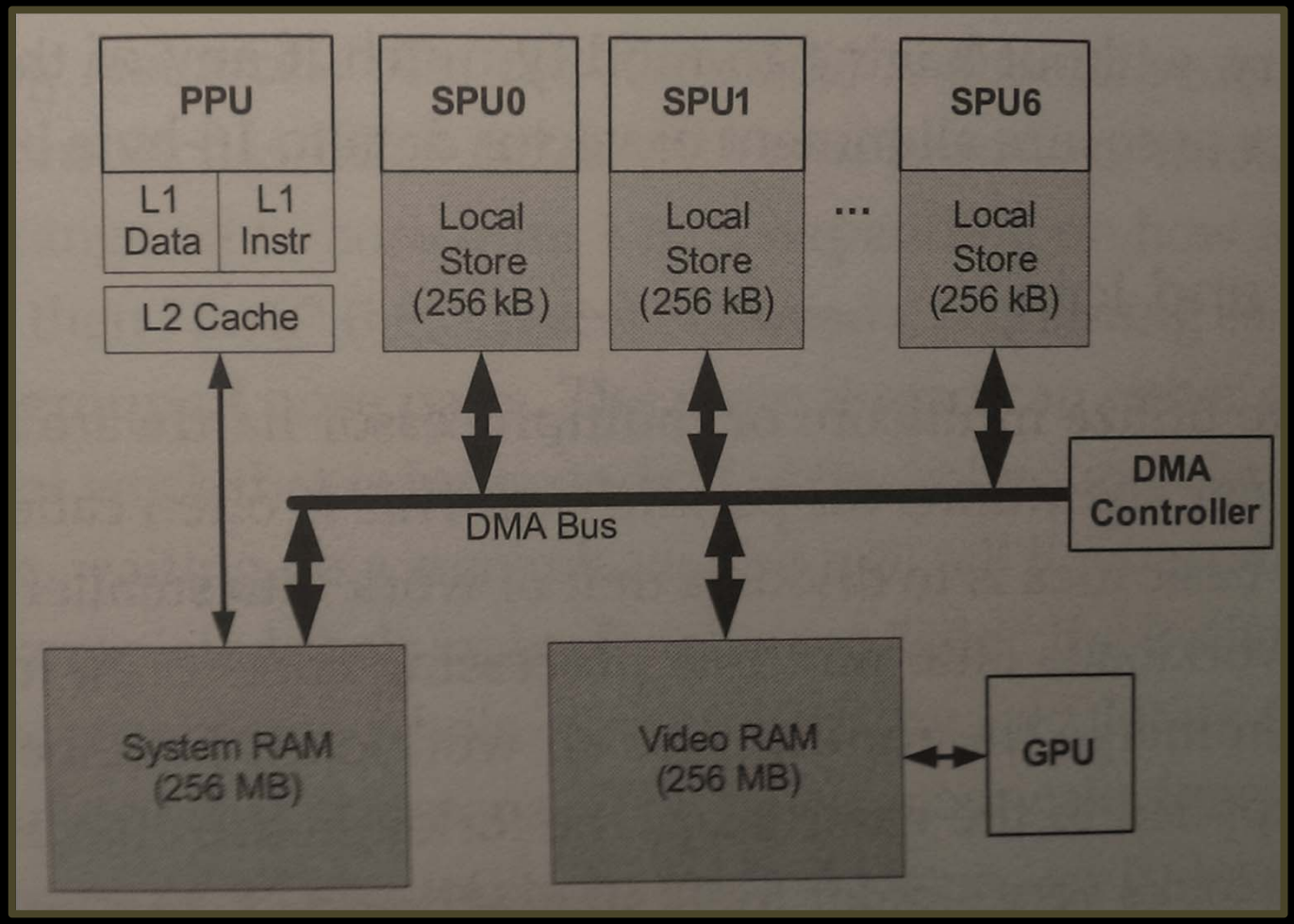
- 2004
  - Heat dissipation prevents faster CPUs!
  - Shift starts towards multi-core CPUs
  - Parallel processing techniques need to be adopted
- PS3 and XBox360 part of this development

- GOAL: Maximize hardware utilization!
  - Slow and painful shift, but mostly there now

# XBox360 Hardware Architecture



# PS3 Hardware Architecture



# 5 Parallelization Techniques

- SIMD
- Fork and Join
- One Thread per Subsystem
- Job Scheduling
- Asynchronous Code

# 1 of 5: SIMD

- Instructions that perform parallel operation on multiple data
  - e.g. Provided by XBox360 and PS3
- Typically 32 bit floating  point data
- Good for 3D math code IF math library well encapsulated!
  - Do you have a function like d = dot(a,b) or are you always calculating d = a.x*b.x+a.y*b.y+a.z*b.z ?

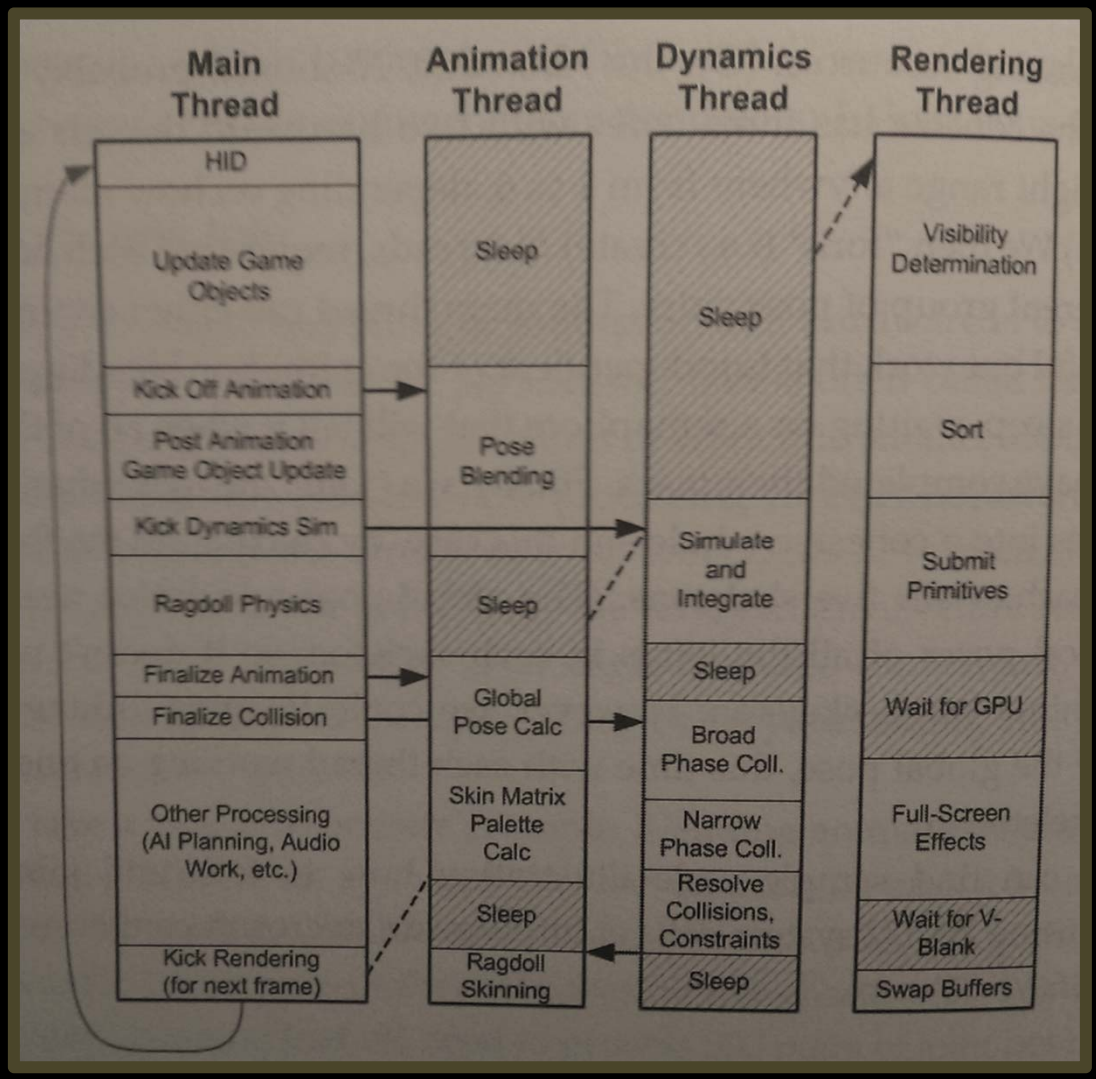
# 2 of 5: Fork and Join

- Divide work into smaller sub-units, distribute and finally merge results
  - E.g. Blending animations with lerps: 5 characters with 100 joints each, resulting in 500 individual lerp operations divied N ways (on XBox360 either 3 ways or 6 ways, since each of the 3 cores can support 2 threads)
- Merge has to be programmed as well, may require waiting on a semaphore

# 3 of 5: One Thread per Subsystem

- Place specialized and fairly independent subsystems on separate threads
  - E.g. main loop, animation, dynamics, rendering
- May introduce restrictions on processor utilization!

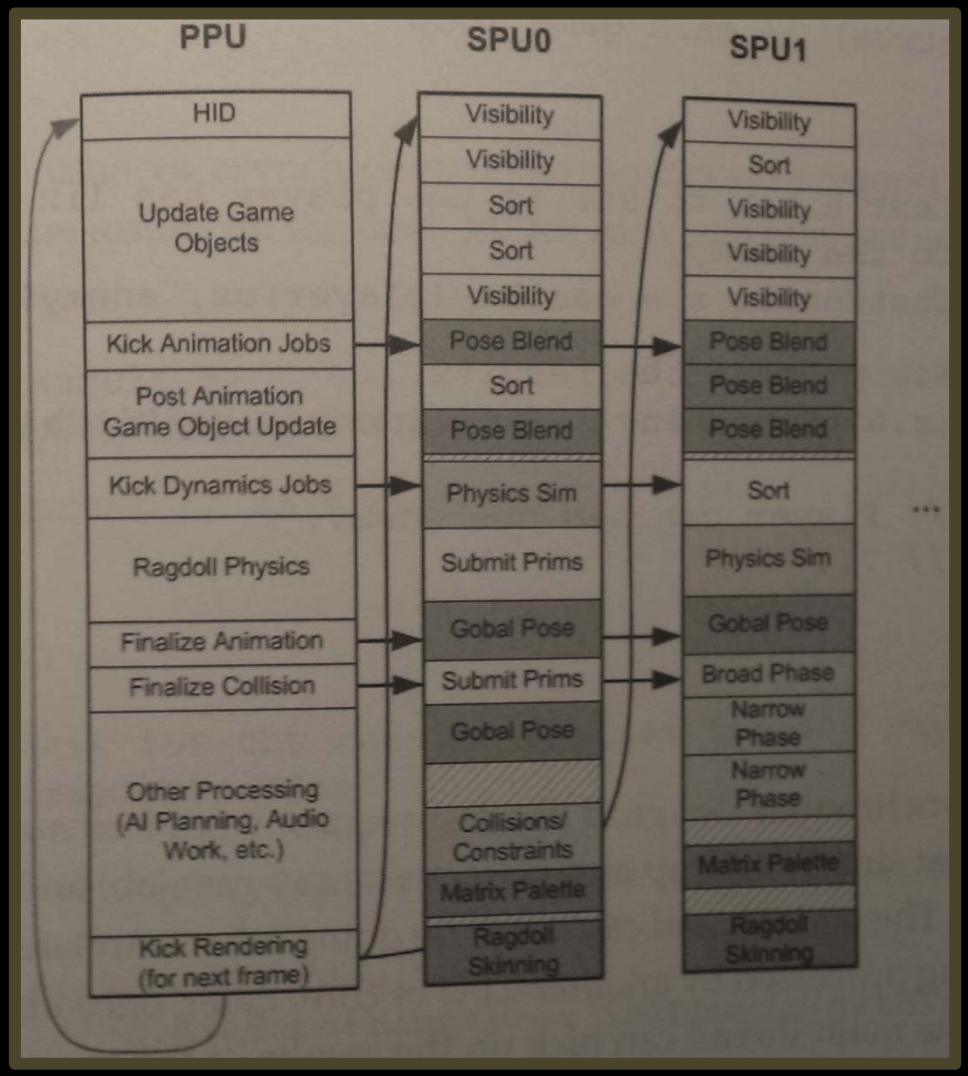
# 3 of 5: One Thread per Subsystem



# 4 of 5: Job Scheduling

- Addresses the sub-system processor utilization restriction
- Work divicded into multiple small, relatively independent jobs
- A job is essentially the pairing of data and code that operates on it
- Jobs are put on queue and picked up by the next available processing unit
- The PS3 SPURS job model does this!

# 4 of 5: Job Scheduling Approach



# 5 of 5: Asynchronous Code

- Design for possible wait until data is ready
- Do other stuff until you absolutely need the data
- Possibly not use data until next frame

See code fragment in book

# Multiplayer Game Loops

- Typical architectures
  - Client-Server
  - Peer-to-peer

# Client-Server

- Client does little more than player-prediction, rendering, audio and networking
- Server runs the game logic
- In client-on-top-of-server mode, the communication between client and server is made easier by putting both in same thread
- Client and server both serviced from same game loop, but at different rates!

See code fragment in book

# Peer-to-Peer

- Each machine acts like the server for some objects and a client for others
- Authority over objects may migrate (e.g. when dropping and adding machines)
- Not always clear which code (server/client) is being run at any given time