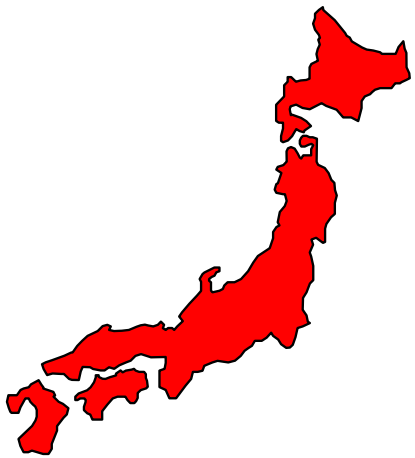
Introduction to PS2

SCEE Technology Group

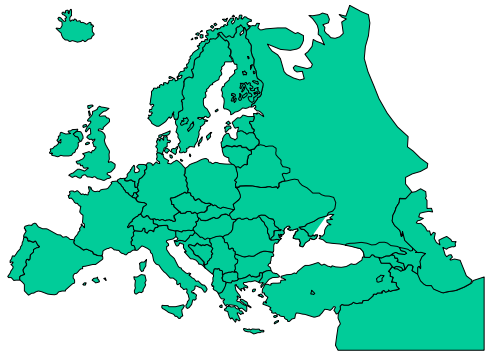
Topics

- Brief history of SCE
- Designing next generation game hardware
- Overview of PS2 hardware
- Comparing PS2 and PC hardware

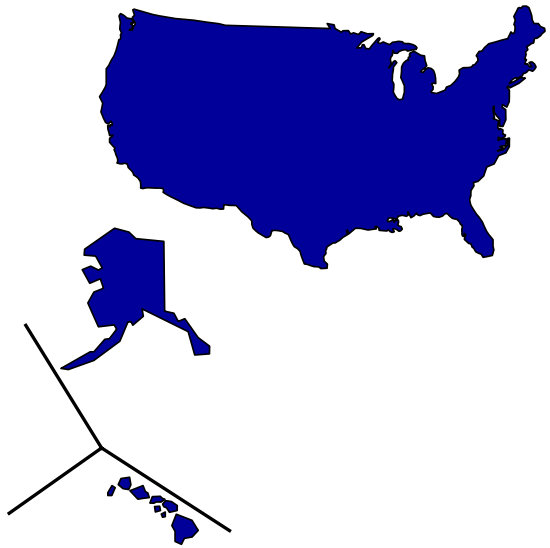
Sony Computer Entertainment



Japan



SCE Europe
(includes Aus,
NZ, Mid East,
Southern Africa)



America

PS2 Sales

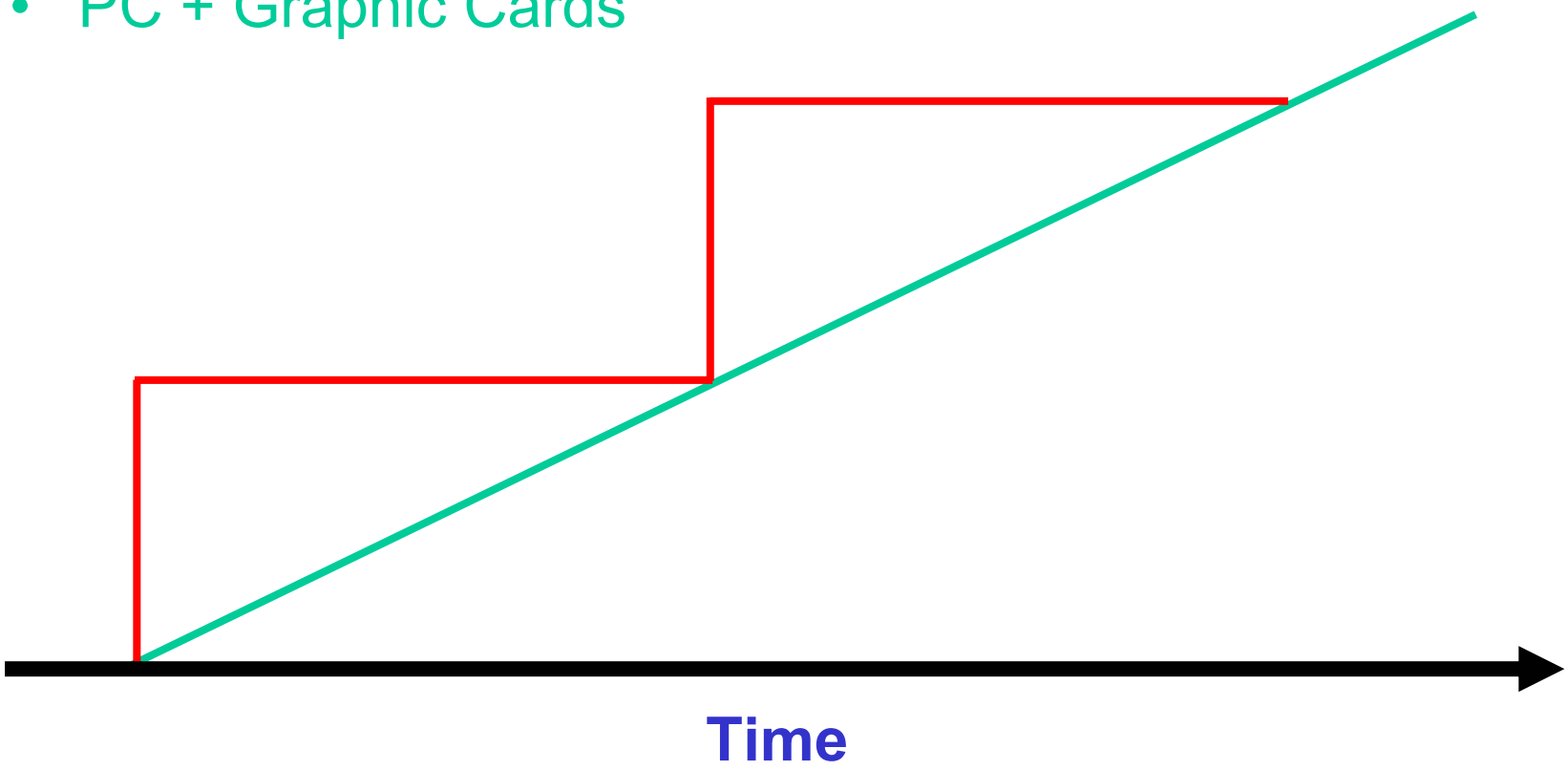
- 40 million sold world-wide since launch
  - Since March 2000 in Japan
  - Since Nov 2000 in Europe/US
- New markets: Middle East, India, Korea, and China
- Long term aim: 100 million within 5 years of launch
- Production facilities can produce 2M/month

History of PS2

- Not long after PlayStation launched in December 1994, work began on a follow up machine
- The goal was to develop a machine using the must cutting edge technology available since console hardware is not upgraded
- This machine would be designed from the ground up to be a dedicated video game architecture

Hardware Performance

- Console
- PC + Graphic Cards



Fixed Hardware

- Developers enjoy fixed hardware!
  - No need to worry about compatibility issues
  - Much easier to optimise game engines and tools
  - Make better games during lifetime of console
- Consumers also enjoy fixed hardware!
  - No need to install or worry about compatibility
  - Games are thoroughly tested before release

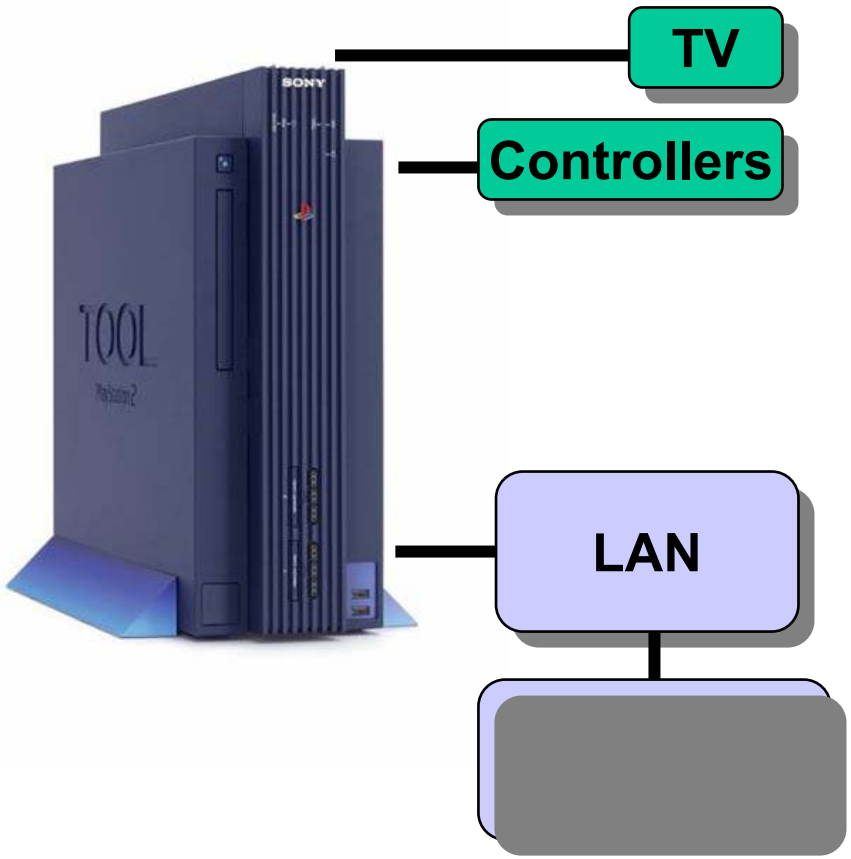
PlayStation vs PlayStation 2

	PlayStation (Dec. 1994)	PlayStation 2 (Mar. 2000)
Frequency	33Mhz	300Mhz
Bus Bandwidth	32bit	128bit
Main Memory	2MB	32MB
VRAM	1MB	4MB
I-Cache	1K	16K
D-Cache	N/A	8K
Display Priority	Z Sorting	Z Buffer
Geometry	3x3 fixed point	4x4 floating point
Voice Channels	24	48
Media	CD-ROM	CD/DVD-ROM

Designing PS2

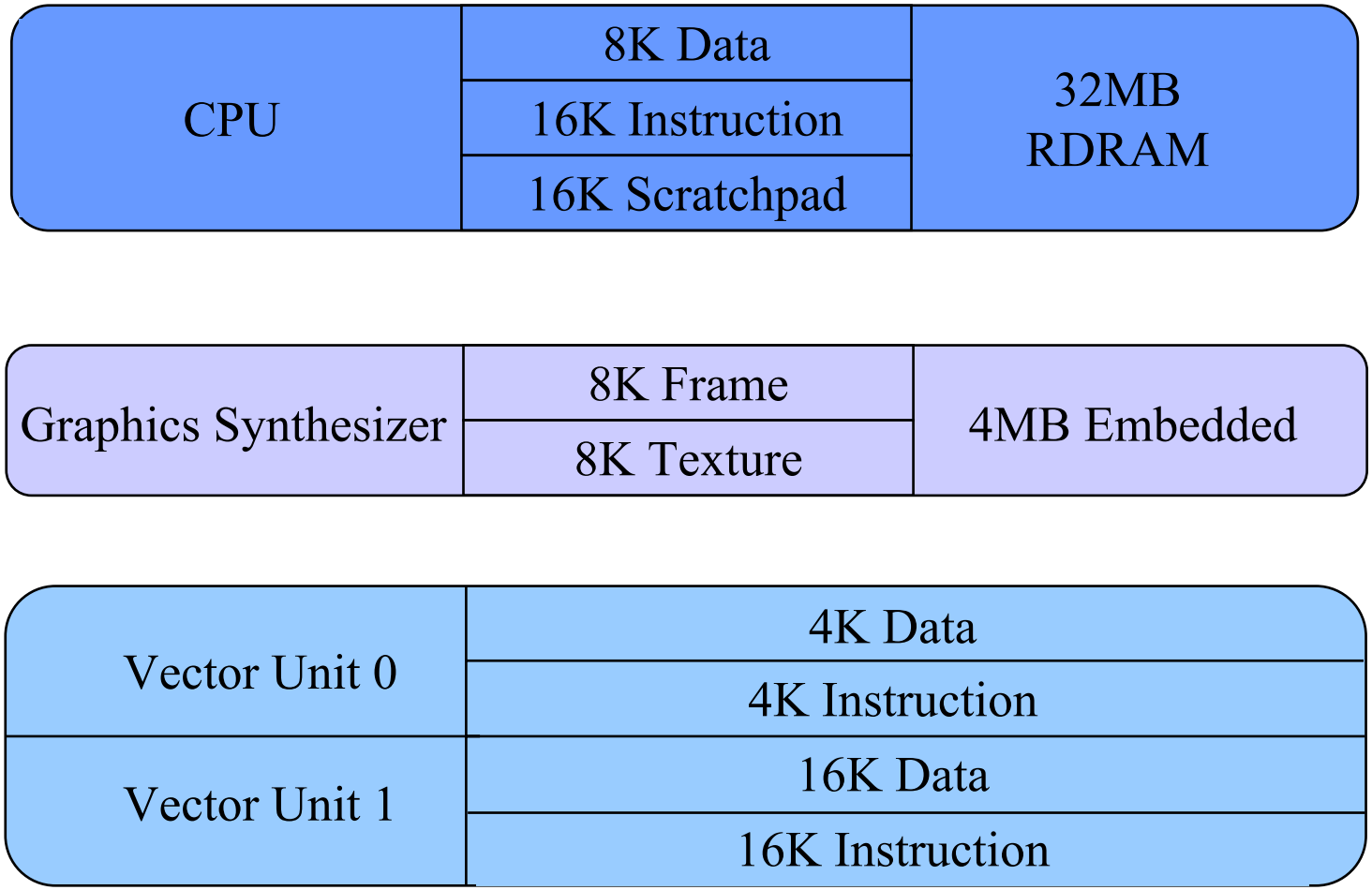
- SCE solved many problems such as:
  - Backward compatibility
  - Pixel Drawing bottleneck
  - Massive floating point capability required
  - Data bandwidth and memory requirements
- This led to design decisions which require a more data driven approach to programming

PS2 Development Environment
The TOOL

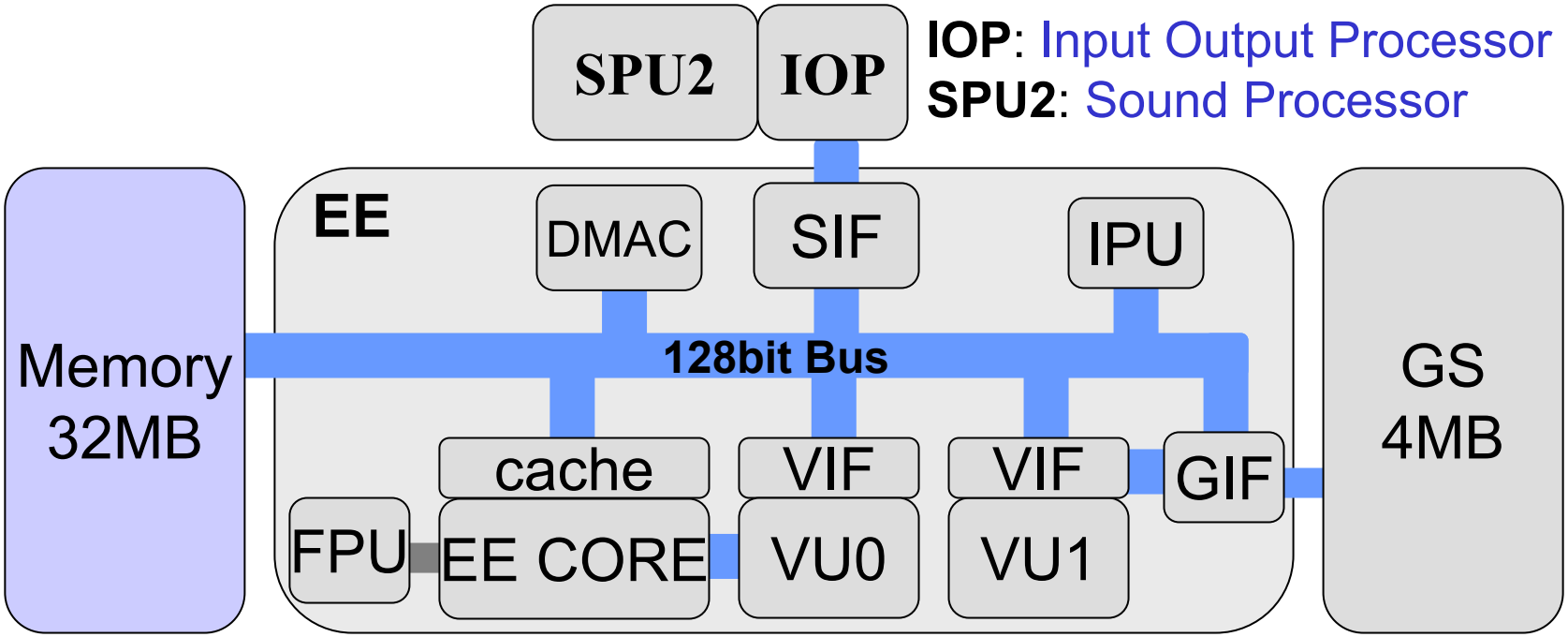


- TOOL = PlayStation 2 with more RAM, and network
- A separate Linux/Windows box runs the compilers and debuggers
  - Connects over the network to the TOOL
- Use Linux-based tools (provided), or 3rd-party Windows development tools

PS2 Memory



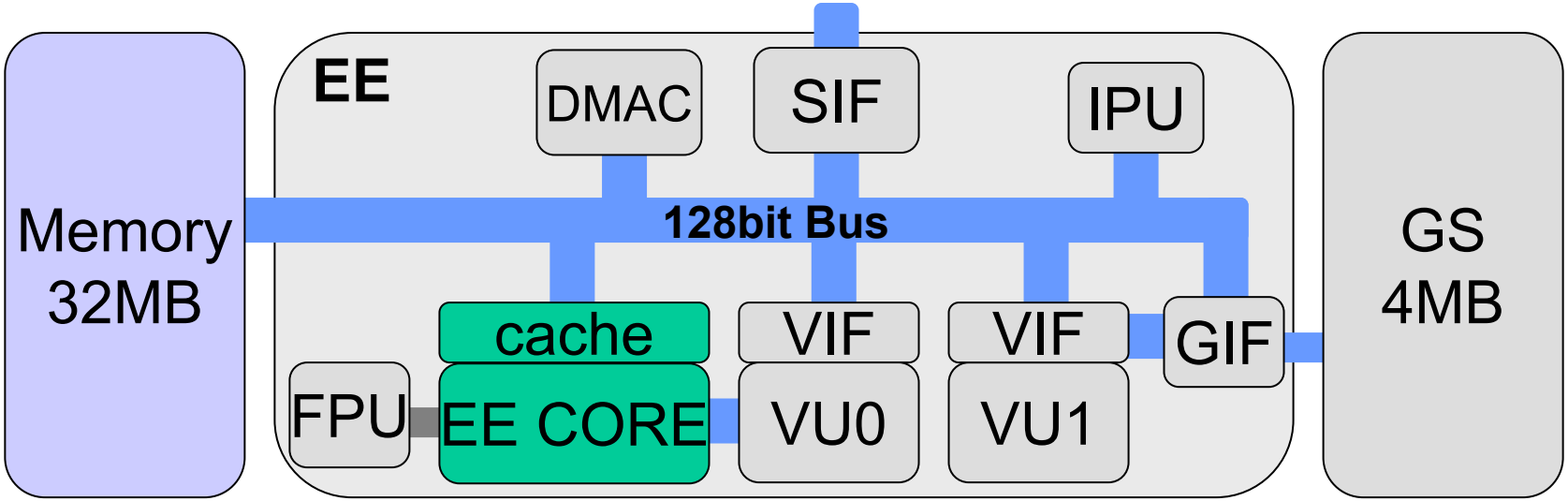
PS2 Architecture

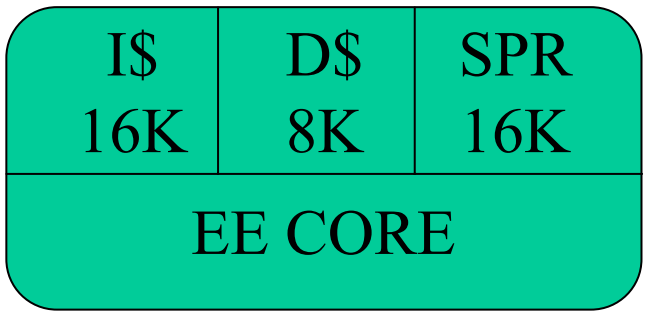


EE: 128bit Emotion Engine
VU0/VU1: Vector Units
FPU: Floating Point Unit

GS: Graphic Synthesiser
DMA: Direct memory access
IPU: Image processing Unit

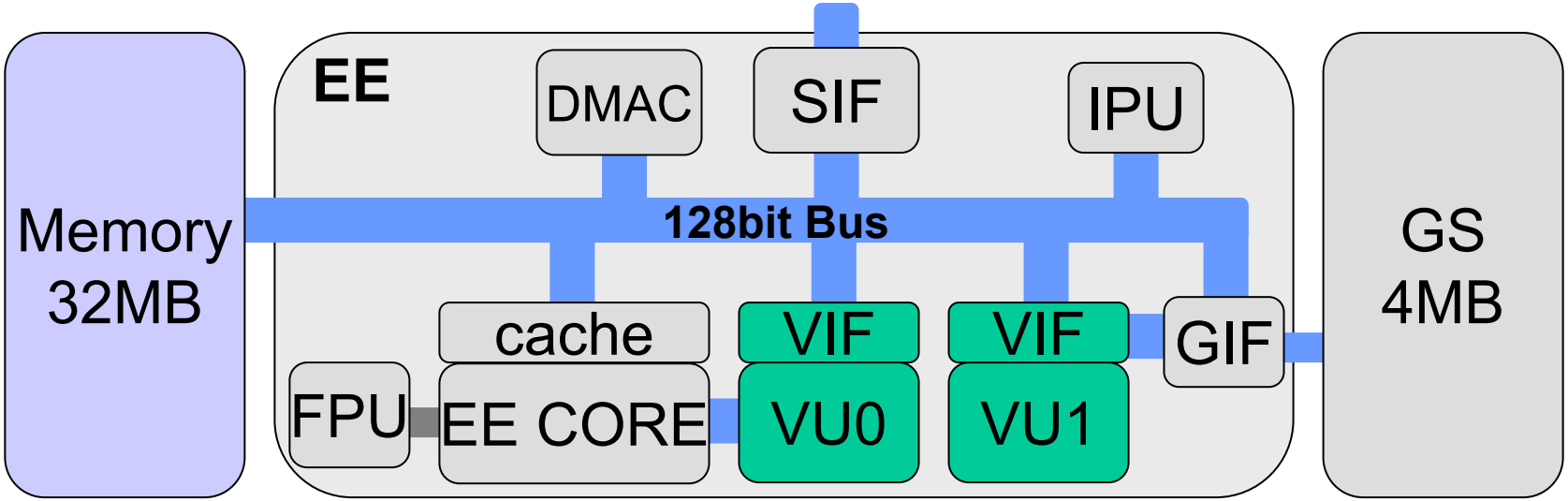
Caches And Scratchpad





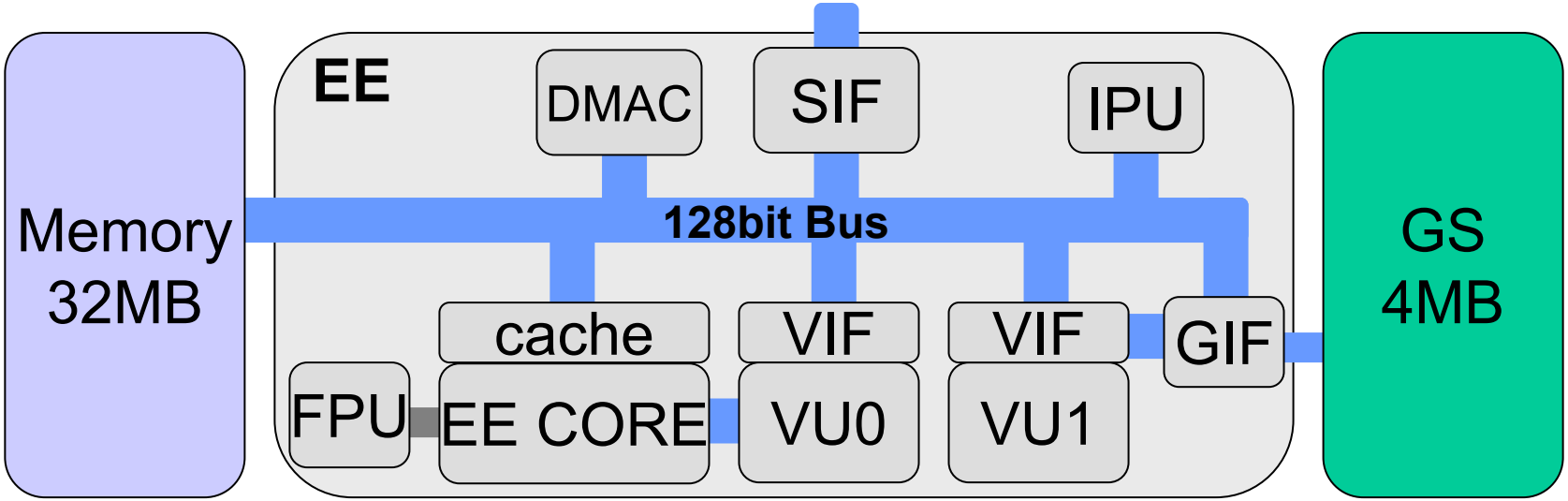
- PS2 has small caches
- Dynamic data is not in the cache for long periods of time

Vector Units



- Two floating point vector unit processors with embedded memory
- A vector unit can do 4 multiplies and 4 adds in a single instruction and can transform about 36M verts/sec
- Argued that the PS2 architecture has shifted the PC paradigm with the emergence of Vertex Shaders

Graphic Synthesiser



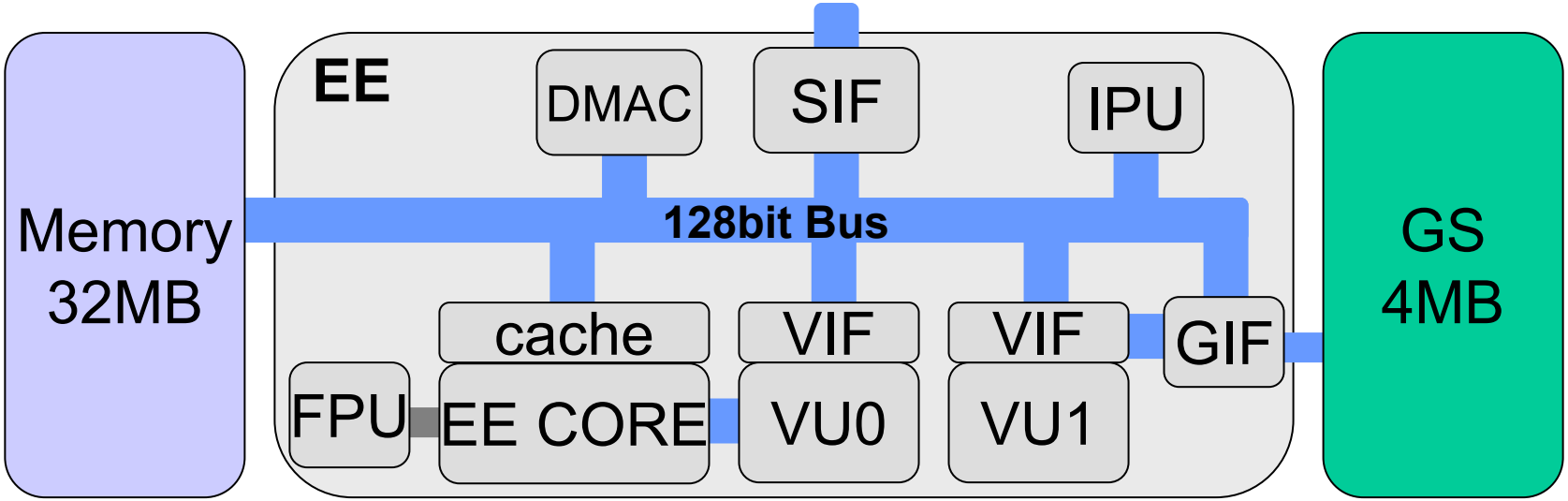
Primitives per second:

- **150**M points
- **50**M textured sprites
- **75**M untextured triangles
- **37.5**M textured triangles

Some Features:

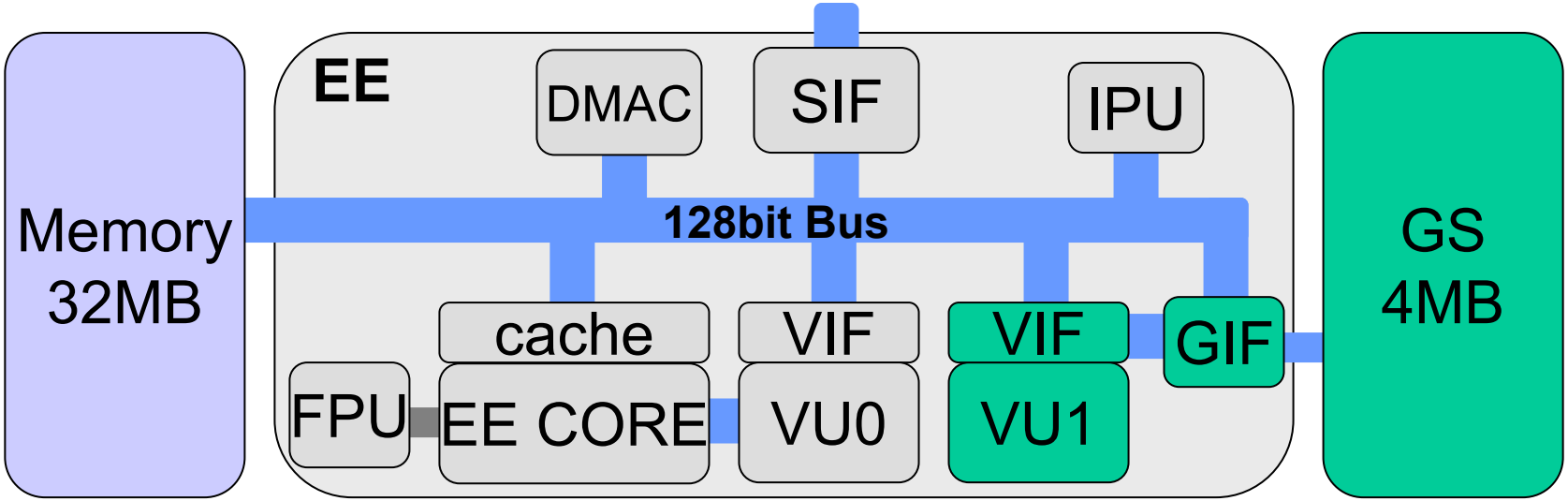
- Very high fill rate
- Alpha blending
- Bi-linear filtering
- Efficient scissoring

GS Fill Rate



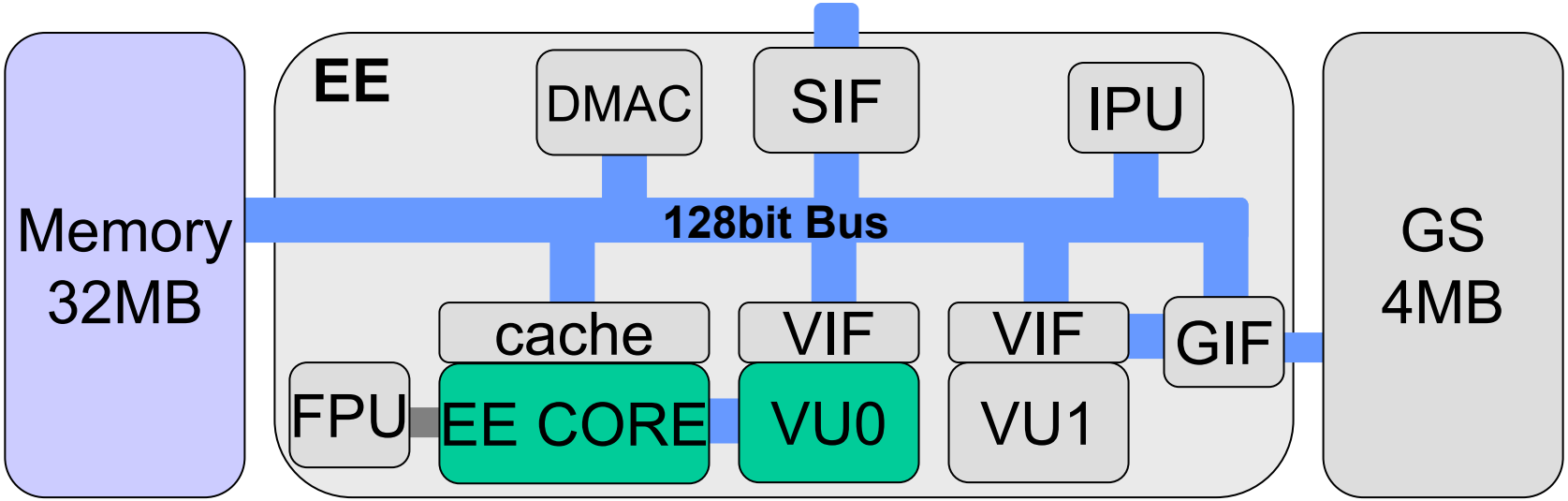
- Bandwidth of 4MB Embedded DRAM 48GB/sec
  - Bandwidth of frame buffer 38.4GB/sec
  - Texture bandwidth 9.6GB/sec
- Fill rate 1.2Giga pixel/sec for textured polygons
- Fill rate 2.4Giga pixel/sec for untextured polygons

GIF Connection For VU1



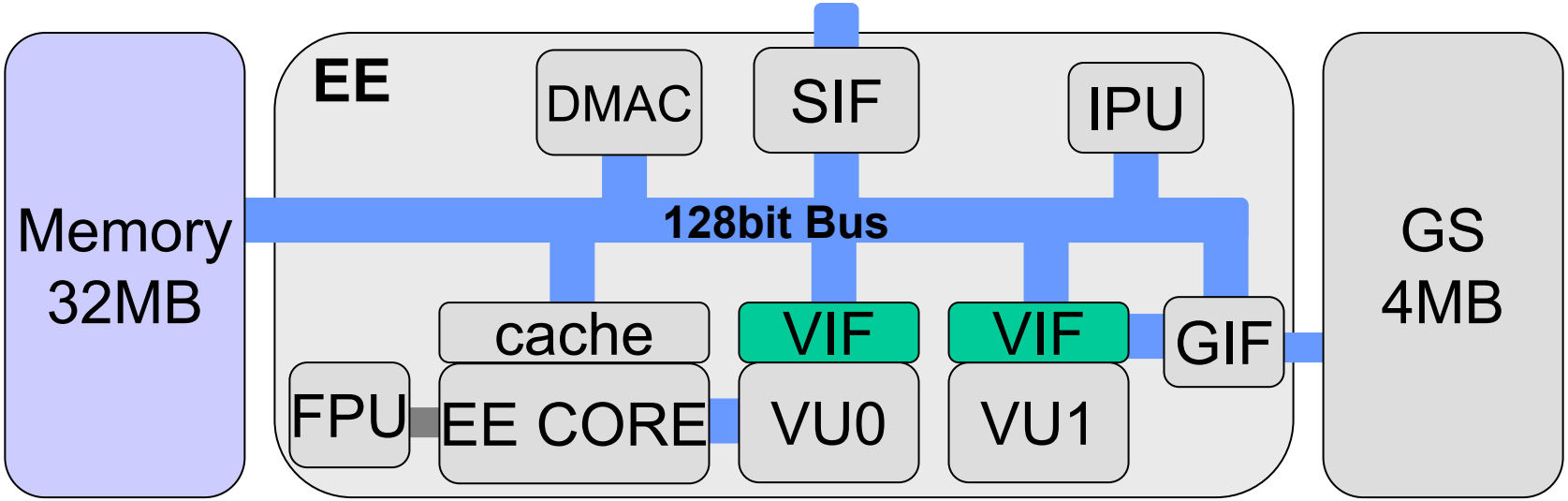
- Vector Unit 1 has a direct path from local memory to the GIF
- Has more internal memory to support double buffering of input and output data
- Enables fast transformation and output to GS

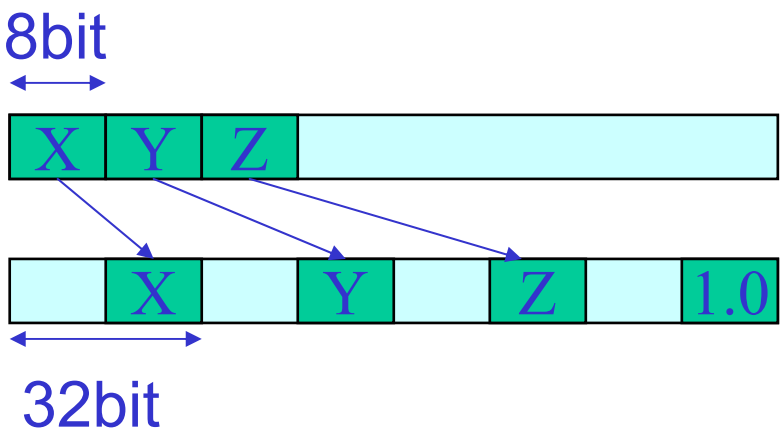
Vector Unit 0 Usage



- Suggested for taking some work off the CPU and help reduce Instruction Cache misses
- Use Vu0 in micro mode to help parallelism with CPU

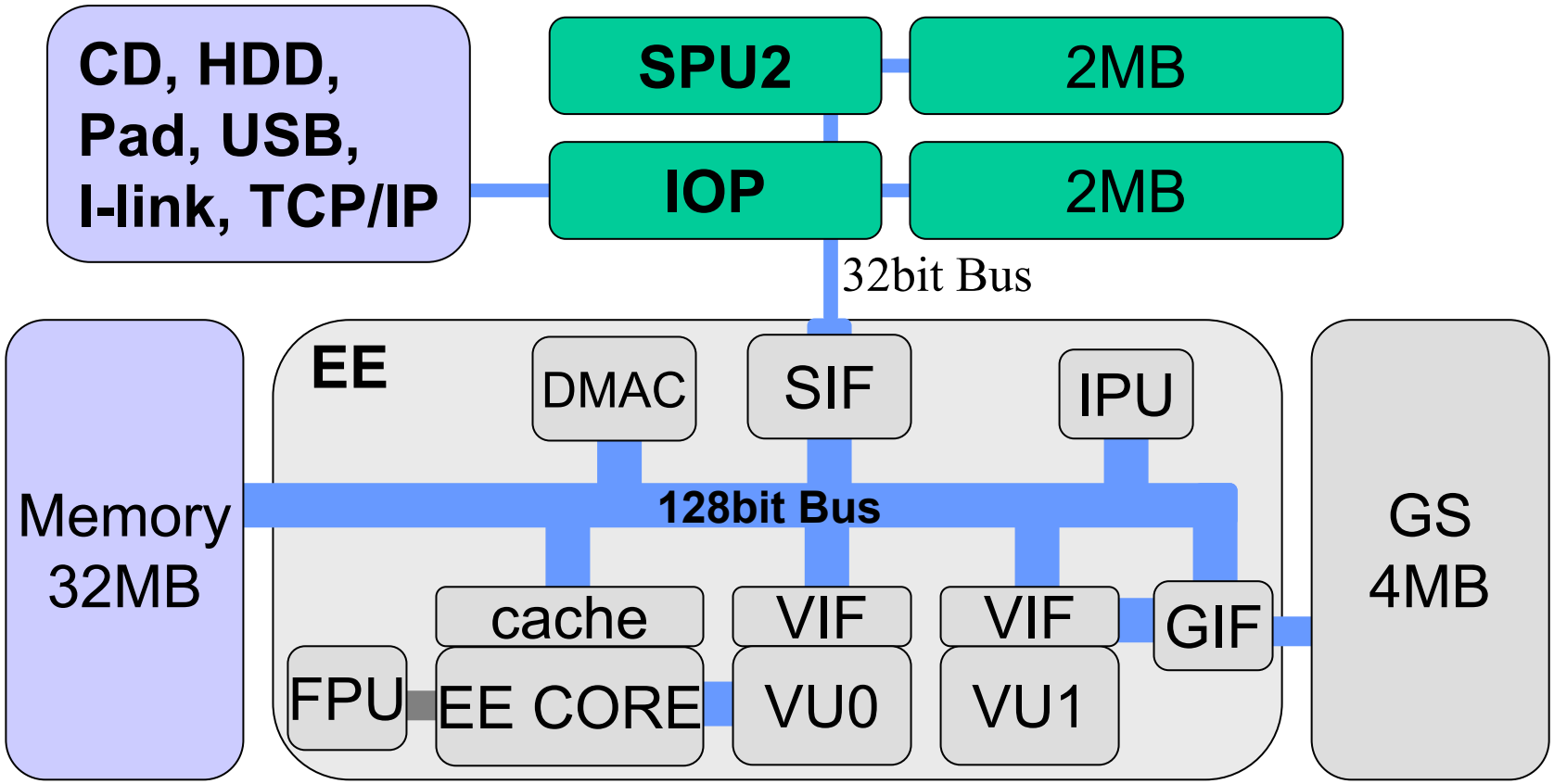
VIF Data Compression/Decompression



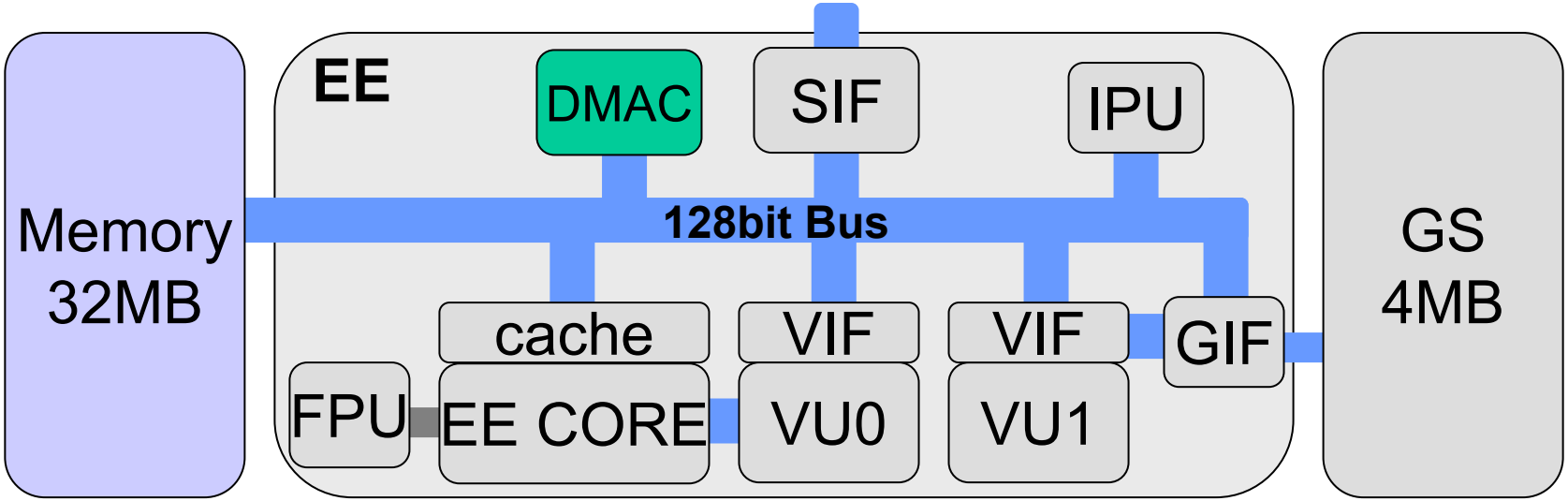


- VIF provides decompression of compressed models
- Compression reduces memory size of model

IOP and SPU

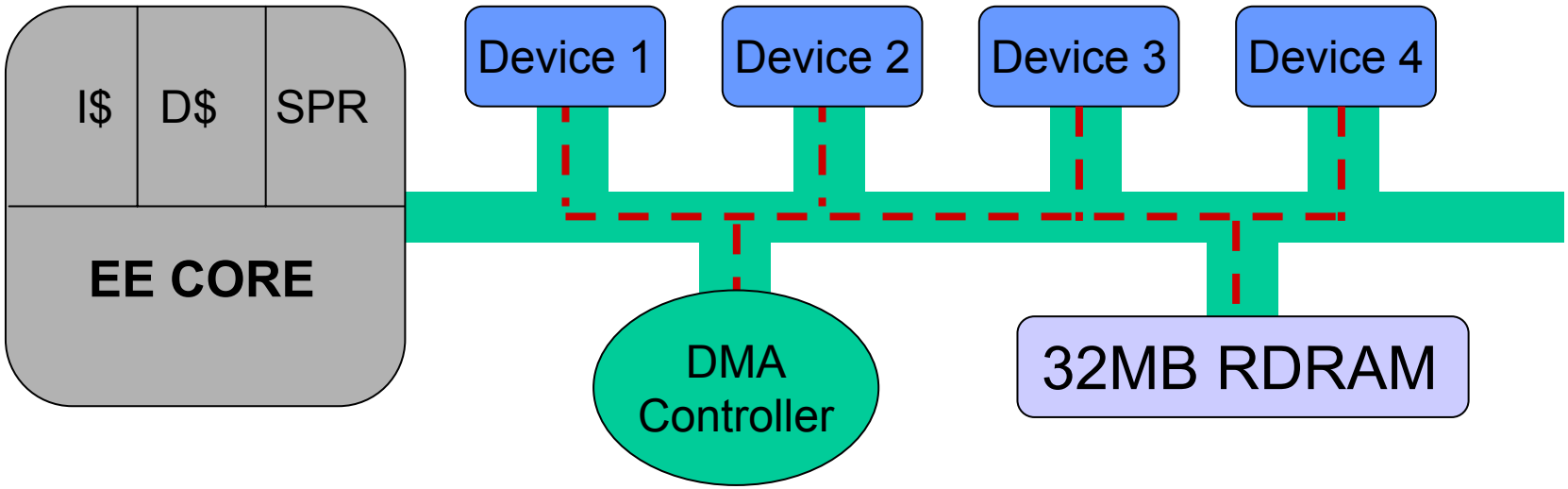


DMA Controller



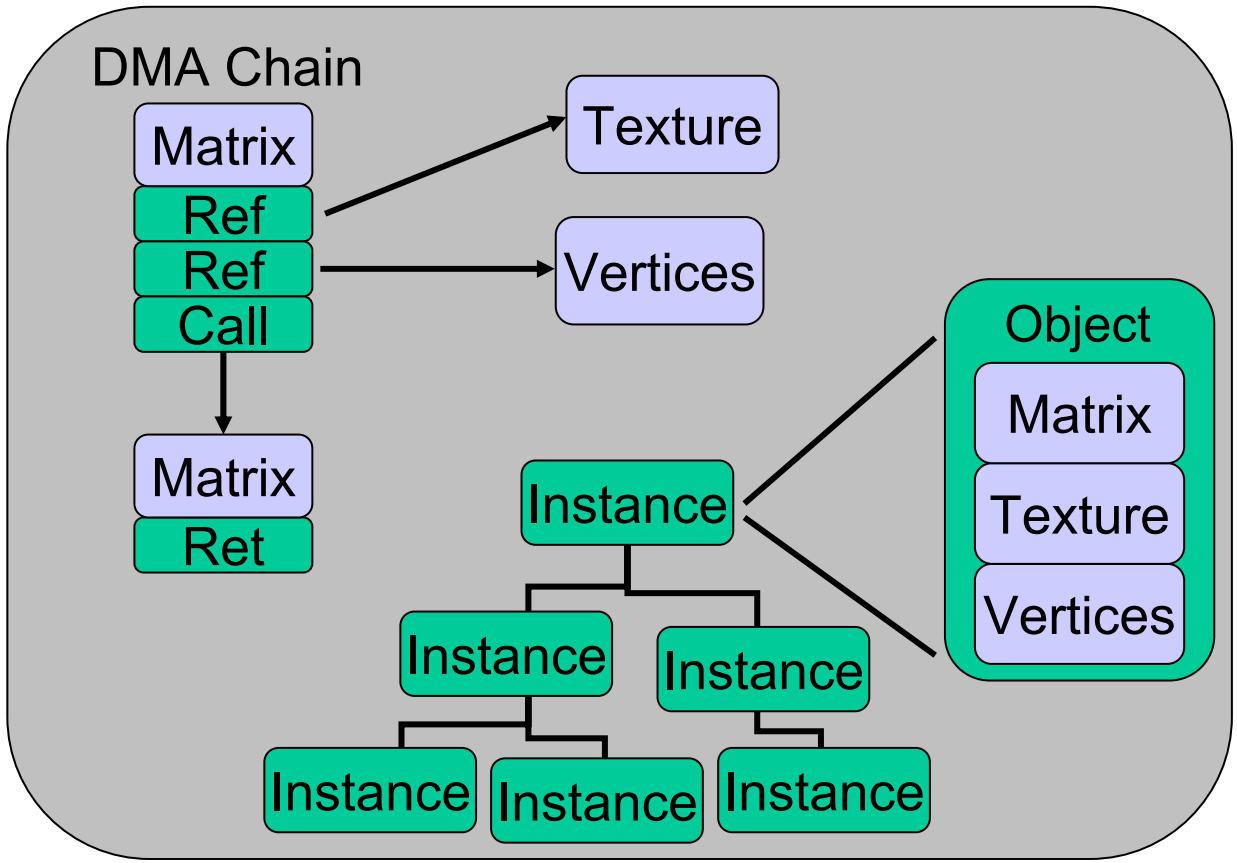
- Main Bus running at 150Mhz giving a total bandwidth of 2.4GB/sec
- The DMAC controls all data transfers in the system
- The DMAC transfers in parallel with the CPU

DMA Transfers

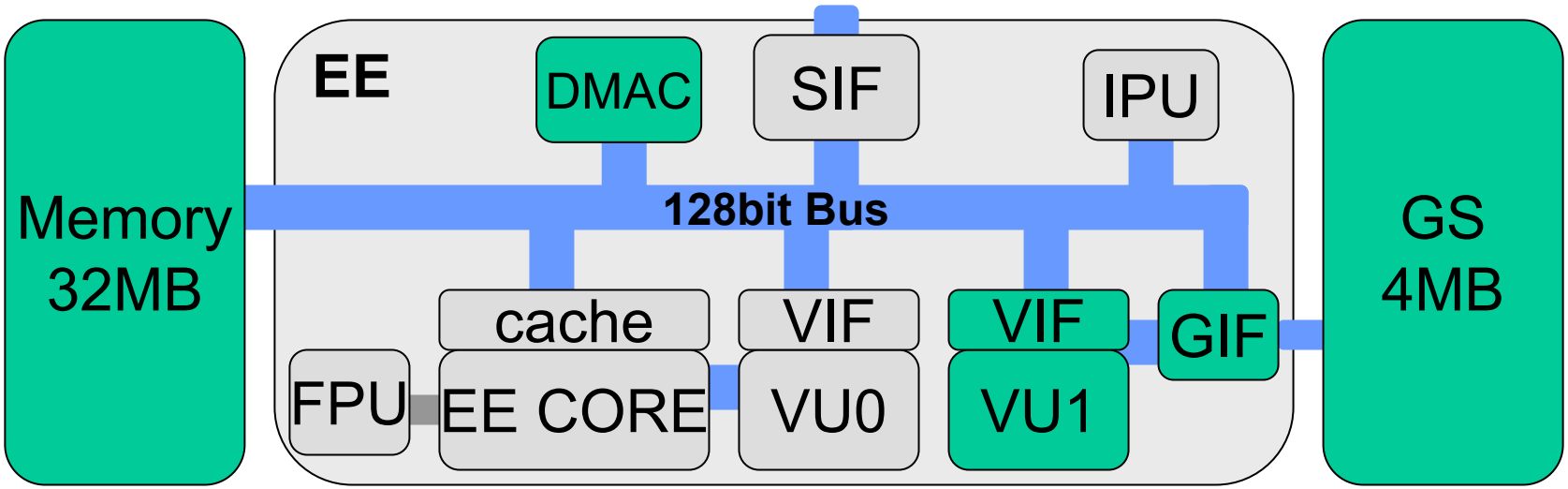


- EE Core issues start signal to DMAC
- Data is transferred in units of 8-QW slices while arbitrating with other DMA channels

Display Lists and DMA Chains

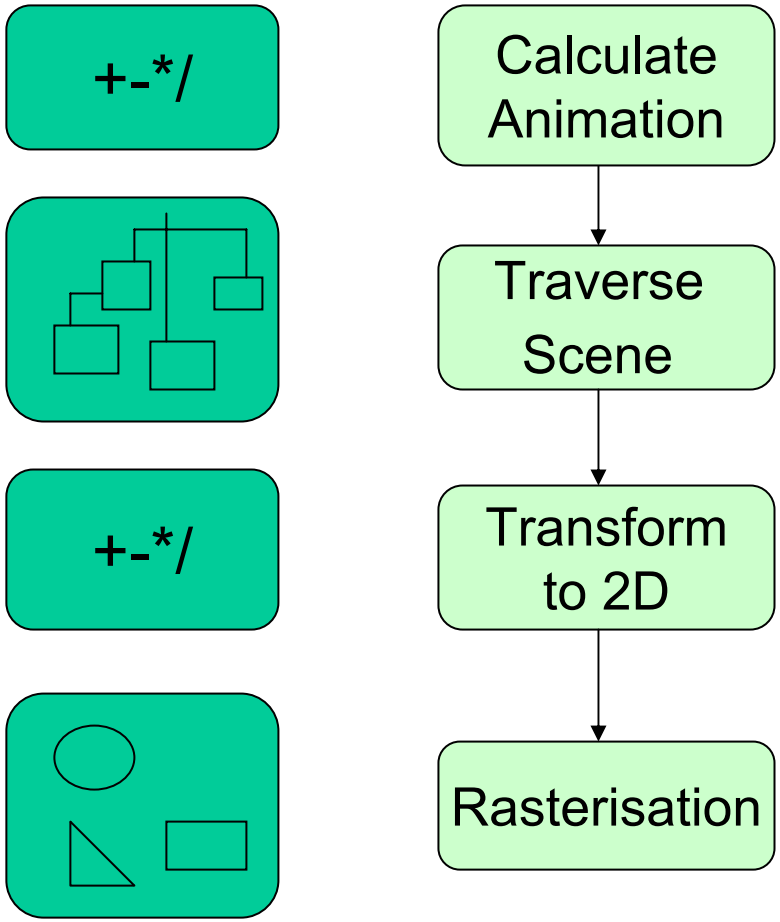


Texture And Geometry Streaming



- Vector Units continue to process data while texture transfer is occurring in the background
- 1.2GB/sec max bandwidth (24MB/Pal Frame)

Rendering Pipeline

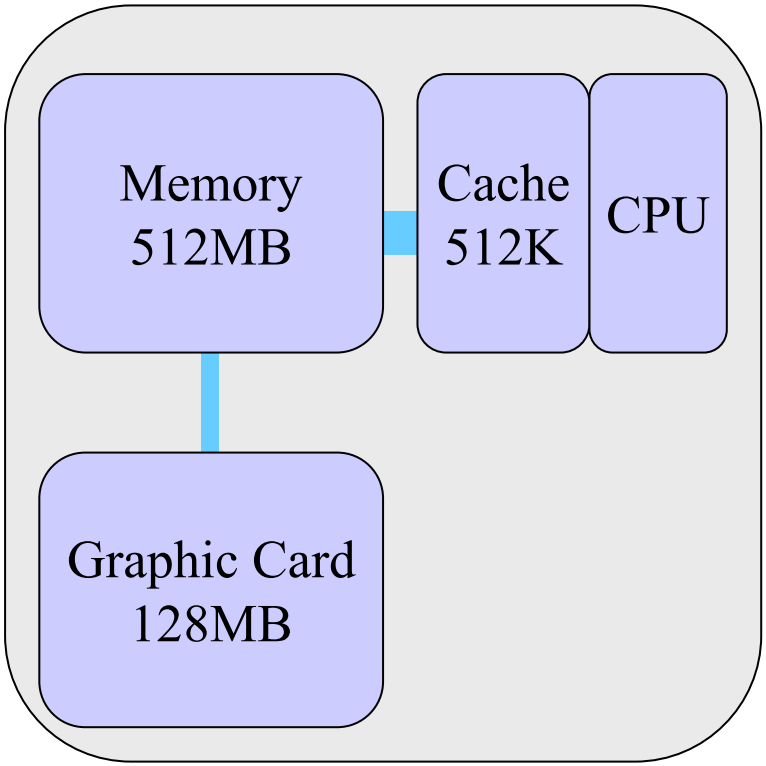


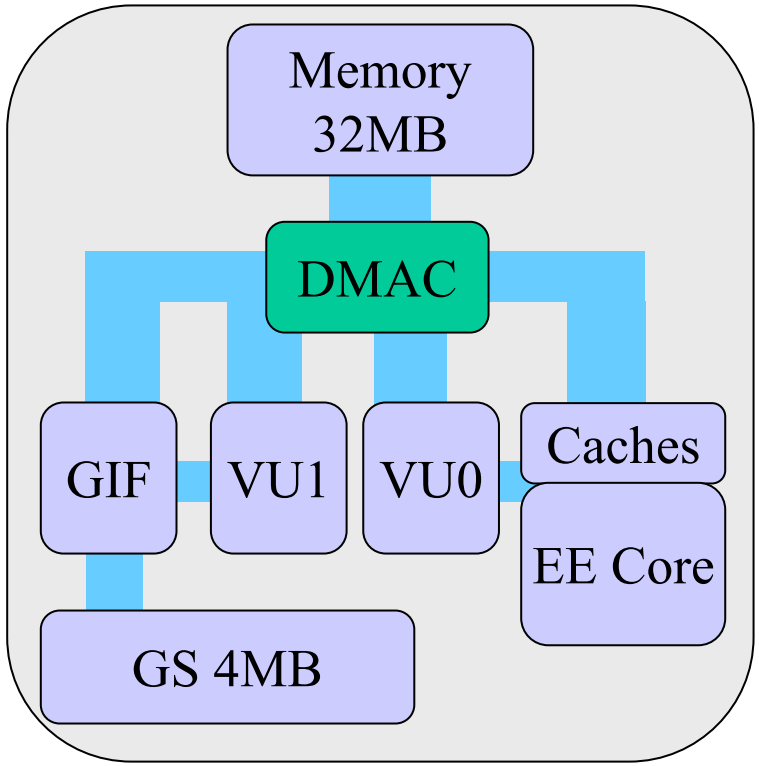
- CPU + Coprocessor VU0
- Traverse DMA list
- VU1
- GS

Differences between PS2 and PC

- Uses parallel units
- Not a single fast CPU
  - Multiple processors with local memory
- Random memory access hits hard
  - Data must be reorganised so that related parts are close to each other in memory
- Optimisation is easier
  - Fixed hardware means optimisation works on all PS2 consoles

Comparing With PC Architecture





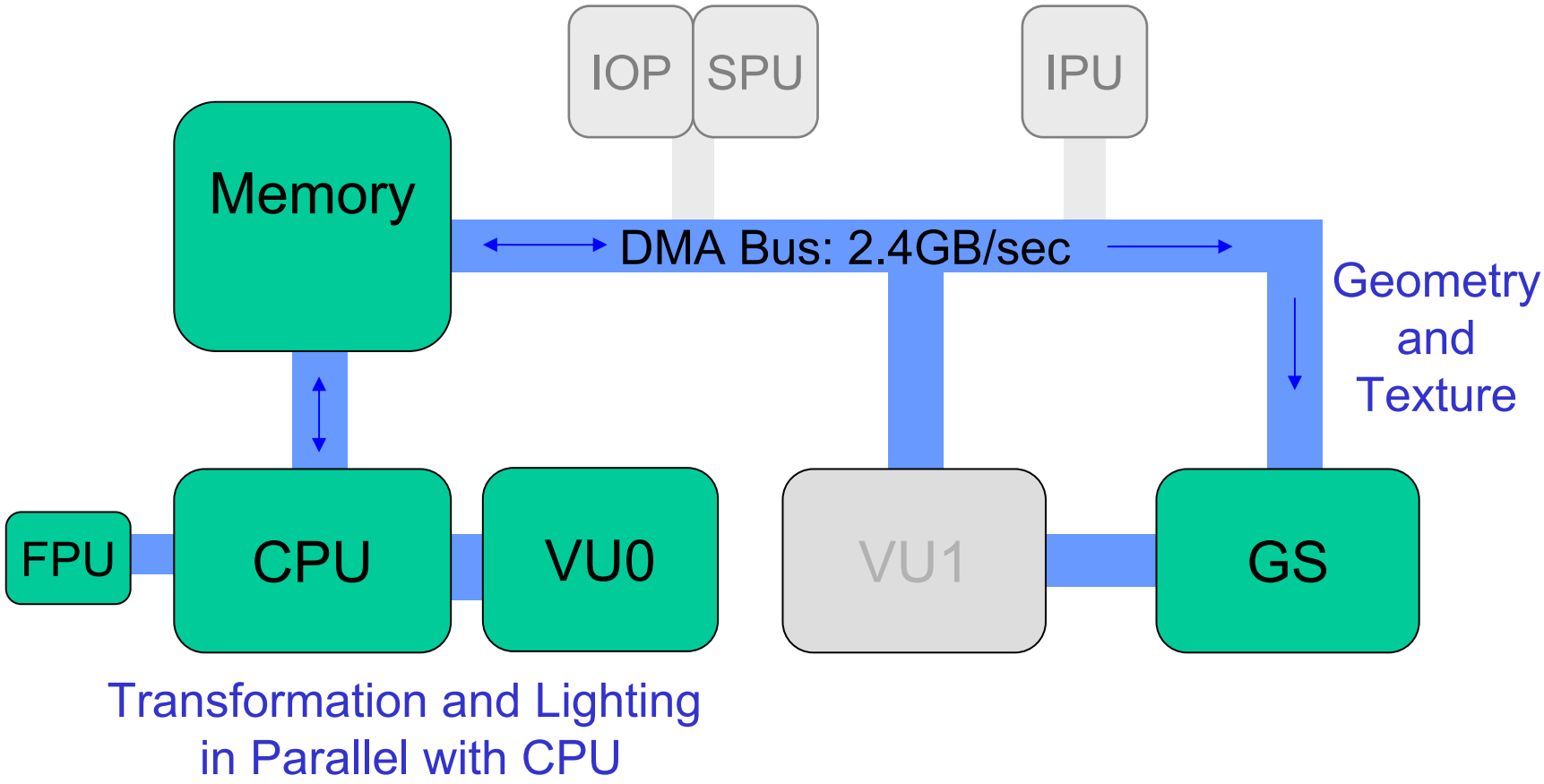
PC Architecture

- Not a fixed platform
- PC code makes use of large caches to compensate for poor bus bandwidth
- PC bus limits geometry performance
- Hi resolution stresses graphics card performance compared to T.V.

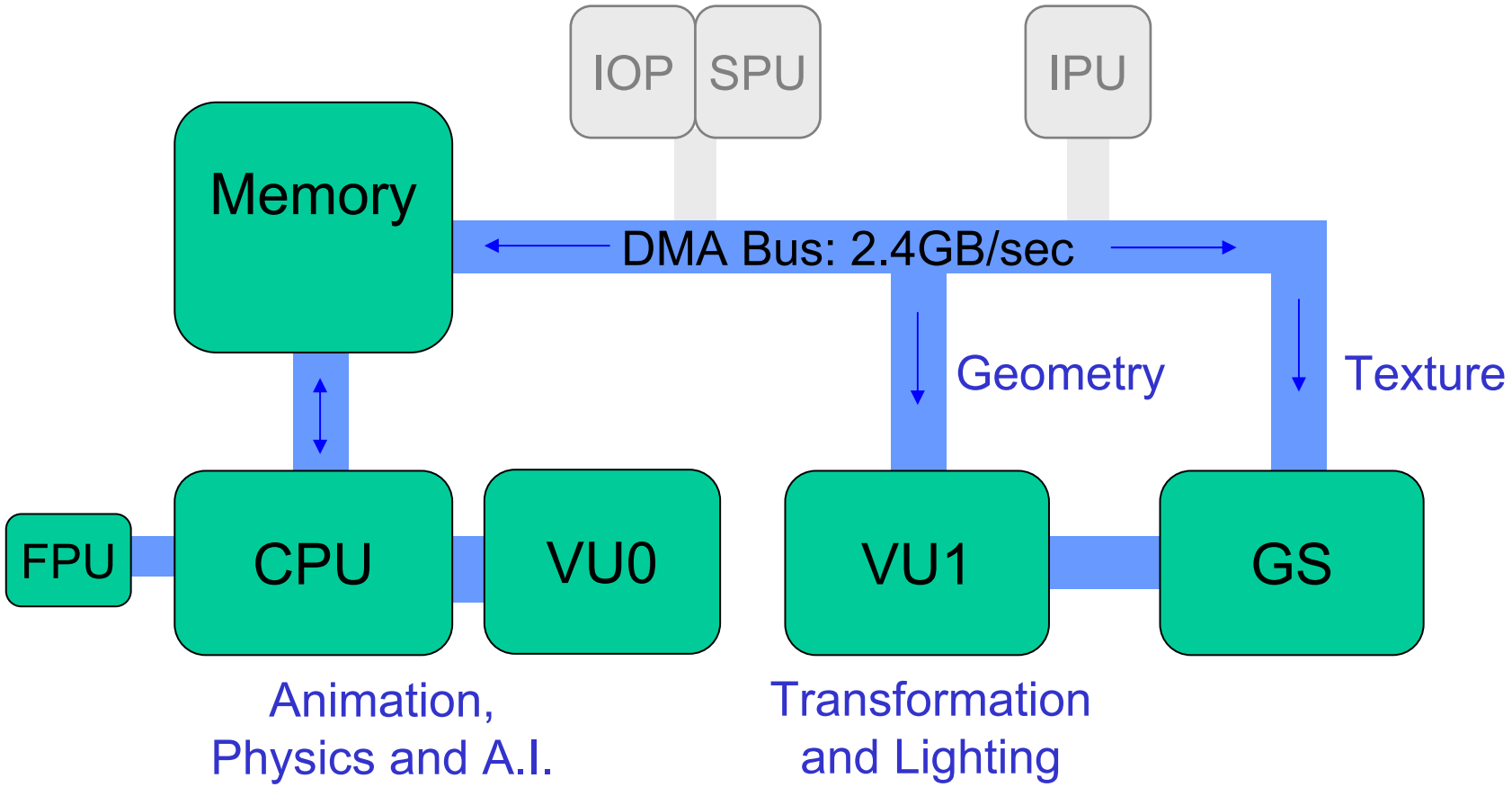
PS2 Architecture

- PS2 has small caches since 128bit data bus can transfer data quickly
- PS2 uses custom coprocessors to handle floating point calculations in parallel
- PS2 runs at TV resolutions so texture requirements are much less

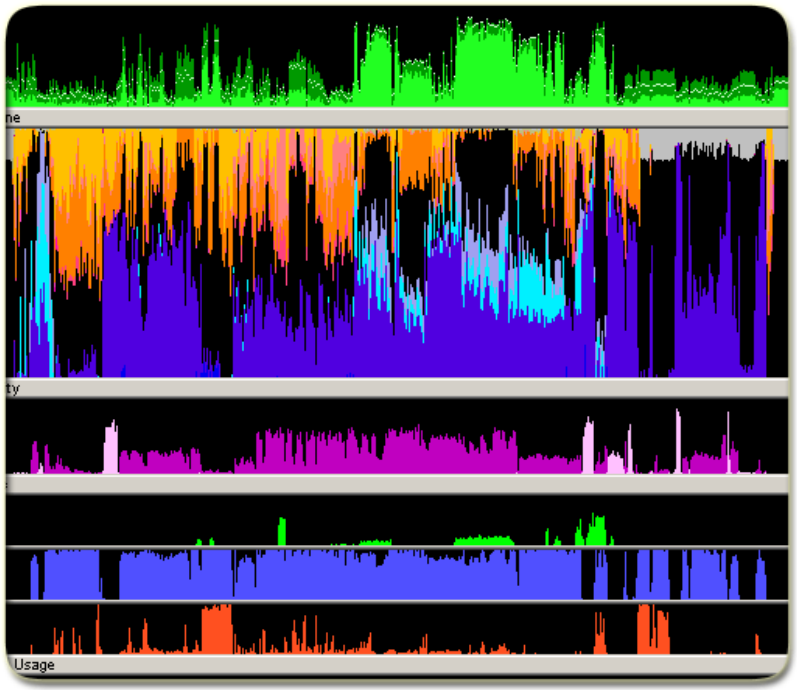
1st Attempt at PS2 Coding



Utilising Full Power of PS2



PS2 Performance Analyser



Network Gaming on PS2

- Network Adaptor
  - Affordable peripheral
  - HDD interface & 100/10 Ethernet port
  - Over 1 million sold in U.S.

Summary

- The PS2 is very flexible and powerful
- Keeping data moving in parallel is the key to keeping the PS2 processors fed with data
- DMA is the most crucial thing to understand to get performance on PS2

Questions

- Want to become a PS2 Developer?
  - Visit www.ps2-pro.com
- SCEE Technology Group
  - Visit www.technology.scee.net