

Q.1 Describe the working architecture of GPU - List and explain various applications of GPU?

- GPU is a specialised electronic device (circuit) designed to rapidly manipulate and alter memory to accelerate the creation of images, in a frame buffered intended for output to a display. GPU comprises of many cores and focus on execution throughout of massively || programs.
- Architecture of CUDA (Compute Unified Device Architecture) capable GPU —:
  - There are 16 Streaming multiprocessors (SMs). Each SM has 8 Streaming processors. (Total 128 SPs). Each SP has a MAD (Multiplication and Addn.) and additional Multiply unit.
  - The GT200 has 240 SPs, and exceeds 1 TFLOP of processing power. Each SP is massively threaded, and can run thousand of threads per application. Each SP supports a max. of 96 threads.
  - The G80 chips has a memory bandwidth of 86.4 GB/s. It also has an 8 GB/s communication channel with the CPU. (4 GB/s for uploading to the CPU RAM, and 4 GB/s for downloading from CPU RAM)
- APPLICATIONS OF GPU COMPUTING:
  - Data Science: Used in Big Data Analytics to make real time business decisions.
  - Machine Learning: Make improvement in image classification, video analytics, speech recognition and natural language processing. It uses multi-level deep neural networks to create system that can perform feature detection.
  - Weather and Climate: WRF (Weather Research and Forecasting model and Tsunami Simulations) has shown tremendous speedups that enable savings in time and improvements in correctness.



- Imaging: The use of GPU in medical imaging has developed to the point that there are several medical modalities shipping with NVIDIA's Tesla GPU's now. Also GPU is used in computer vision and img. processing algo. which are computationally intensive.
- Media and Entertainment: GPU is used to deliver fast results while working with more video streams at a time. Also it delivers high performance graphics and // processing.
- Bio-Informatics: Sequencing and protein docking are very calculation intensive tasks for which GPU are used.
- Computational Finance and Computational Fluid Dynamics.
- Defense and Intelligence: Converting collected raw data into actionable info. requires significant infrastructure - people, computer hardware and software.
- Electronic Design Automation: GPU's are used for a varied set of software algo. and applications that are reqd. for the design of complex next gen. semiconductor and electronic products.

Q.2 Explain the purpose of using supercomputer. List few supercomputers utilized for critical application.

- Supercomputers are used for carrying out complex, fast and time intensive calculations for scientific and engineering applications. They are used in various fields like weather forecasting for global climate changes, quantum mechanics, military, chemical composition and polymer research.
- ~~currently~~ • Applications of supercomputer with explanation:
  - Recreating the big-bang: complex visualisations related to big-bang are done using supercomputers.
  - Understanding the earthquakes: supercomputers do so by modelling the 3-D structure of Earth, researchers can predict how earthquake waves will travel.



- Folding Proteins : Supercomputers are used to study about "Blue Gene".
- Mapping the blood-Stream : Supercomputers are used to map blood flow through complex system of veins and arteries in real time.
- Modelling Pandemics : Potential pandemics require a fast response on two fronts. First, researchers have to figure out how the virus is spreading. Second, they have to find drugs to stop it.
- Testing Nuclear weapons : Computer simulations to ensure that the country's cache of nuclear weapons are functional and safe.
- Forecasting hurricanes : "Ranger" supercomputer, with its cowboy monitor and 579 trillion calculations per second, resides at TACC in Austin to forecast hurricanes.
- Building Brains : "Dawn", a supercomputer at Lawrence Livermore National Lab., can simulate the brain power of a cat — but 100 to 1000 times slower than a real cat brain.
- Automobile Safety Ratings : Supercomputers play a very important role in helping people decide what car to buy. When auto manufacturers subject their vehicles to safety testing, only a fraction of testing is done in a live, simulated environment with a dummy.
- Few Supercomputers utilised for critical application :
  - Sunway Taihu Light : World's fastest computer with rating of 93 peta flops per second.
  - PARAM 8000 : First supercomputer developed in India in 1990.



- Cray-1: developed in year 1976. It was first general purpose supercomputer which used Vector Processor machines. later used for large scale problems in science and engineering.
- Sequoia: IBM's supercomputer at Lawrence National Lab in California.
- Ranger: Described in earlier part of answer.
- Dawn: Described in earlier part of answer.