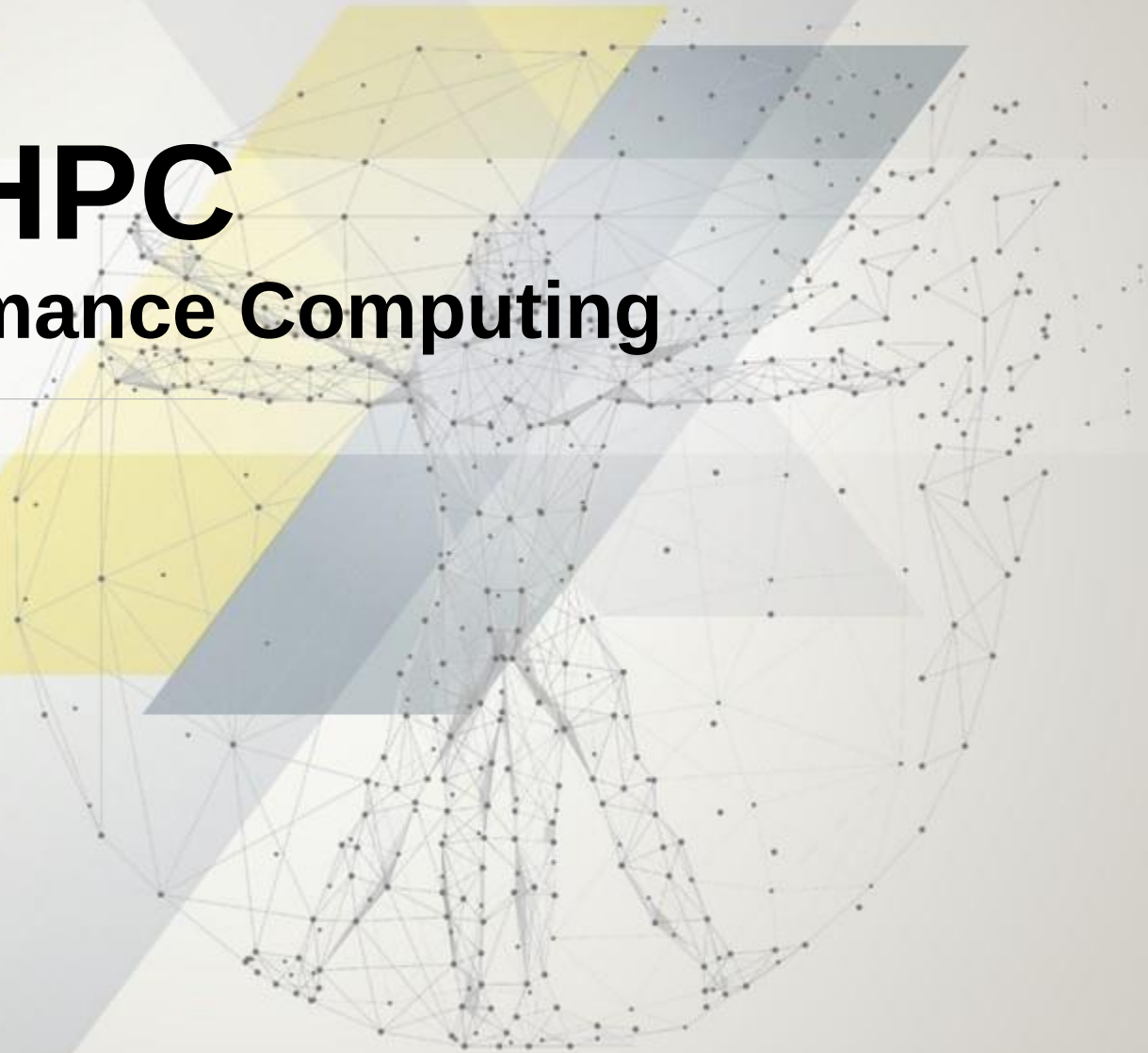
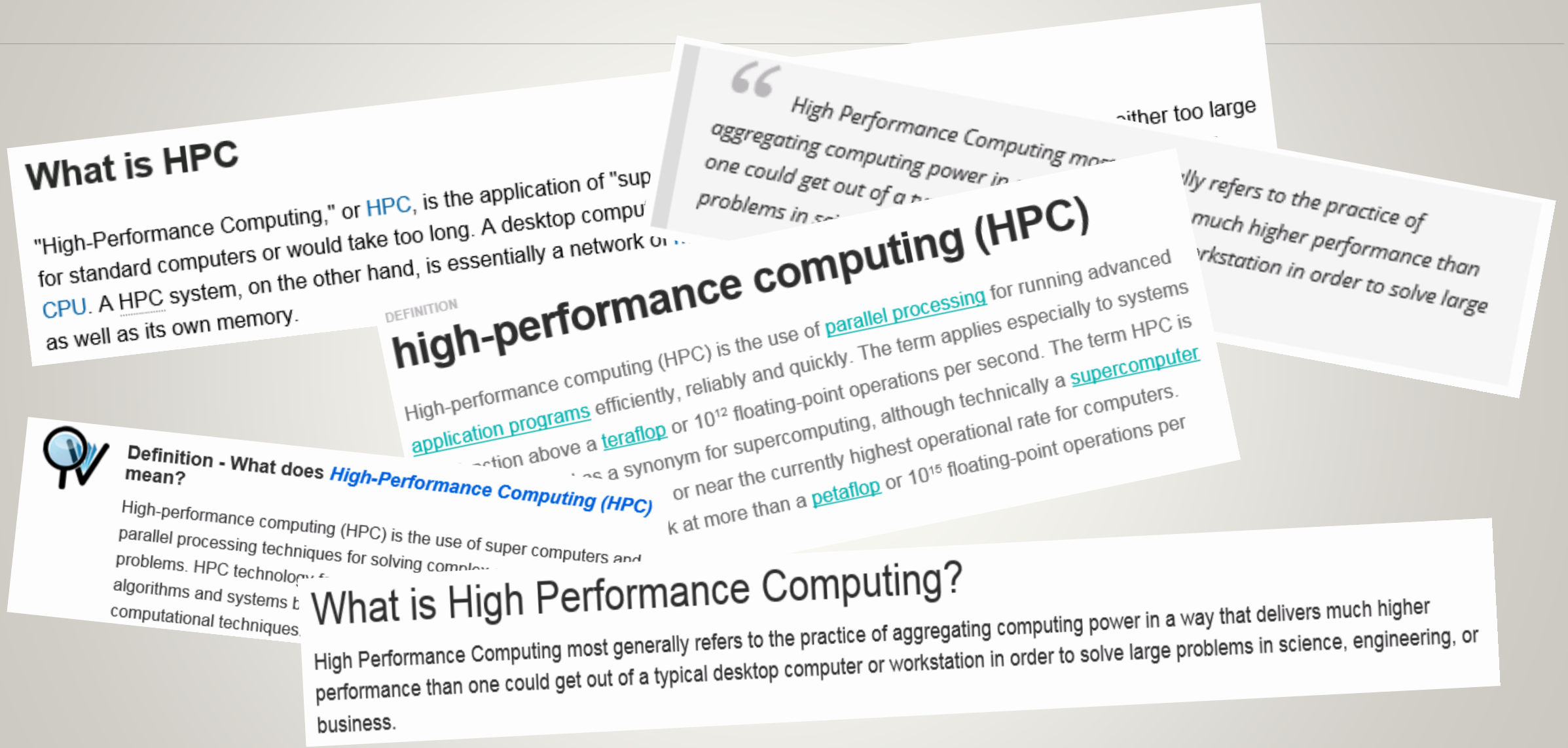
HPC

High Performance Computing



What is HPC?


What is HPC
"High-Performance Computing," or HPC, is the application of "sup
for standard computers or would take too long. A desktop compu
CPU. A HPC system, on the other hand, is essentially a network o
as well as its own memory.
DEFINITION
high-performance computing (HPC)
High-performance computing (HPC) is the use of parallel processing for running advanced
application programs efficiently, reliably and quickly. The term applies especially to systems
ction above a teraflop or 10^12 floating-point operations per second. The term HPC is
as a synonym for supercomputing, although technically a supercomputer
or near the currently highest operational rate for computers.
k at more than a petaflop or 10^15 floating-point operations per
Definition - What does High-Performance Computing (HPC) mean?
High-performance computing (HPC) is the use of super computers and
parallel processing techniques for solving
problems. HPC technolo
algorithms and systems
computational techniques
What is High Performance Computing?
High Performance Computing most generally refers to the practice of aggregating computing power in a way that delivers much higher
performance than one could get out of a typical desktop computer or workstation in order to solve large problems in science, engineering, or
business.

What is HPC – Mission Statement

*The use of **parallel*** processing for running advanced application programs **efficiently** and **quickly** in terms of:*

Speed - Reducing time-to-solution
Energy efficiency - Doing more with less power
High throughput - Handling large volumes of data in real-time

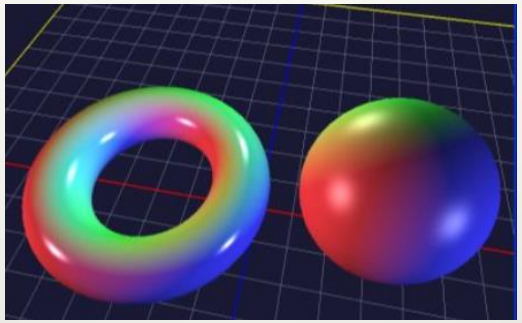
** By utilizing all available resources*

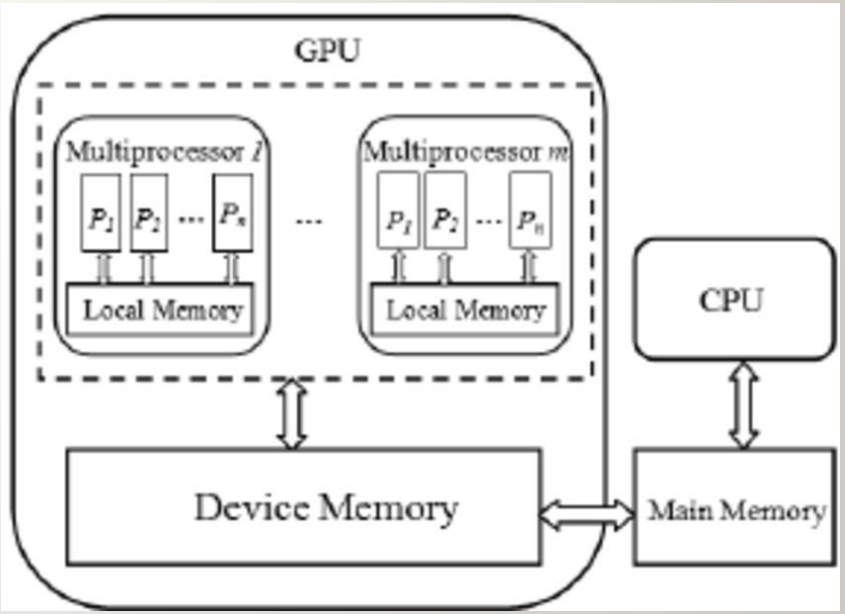
Resources

CPU vs TPU vs GPU

GPGPU – Short History

- 90's: GPU – Graphics Processing Unit
  - Dedicated hardware for graphics
- 2001: Programmable Pipeline Introduced.
  - Small processing units ("shaders")
  - Optimized for matrix multiplication tasks
  - Idea: set color/intensity for each pixel **in parallel**
- 2006: GPGPU – General Purpose GPU
  - Use those processing units ("cores") for math
  - From **sequential** to **parallel** processing
- 2014: NVIDIA Jetson

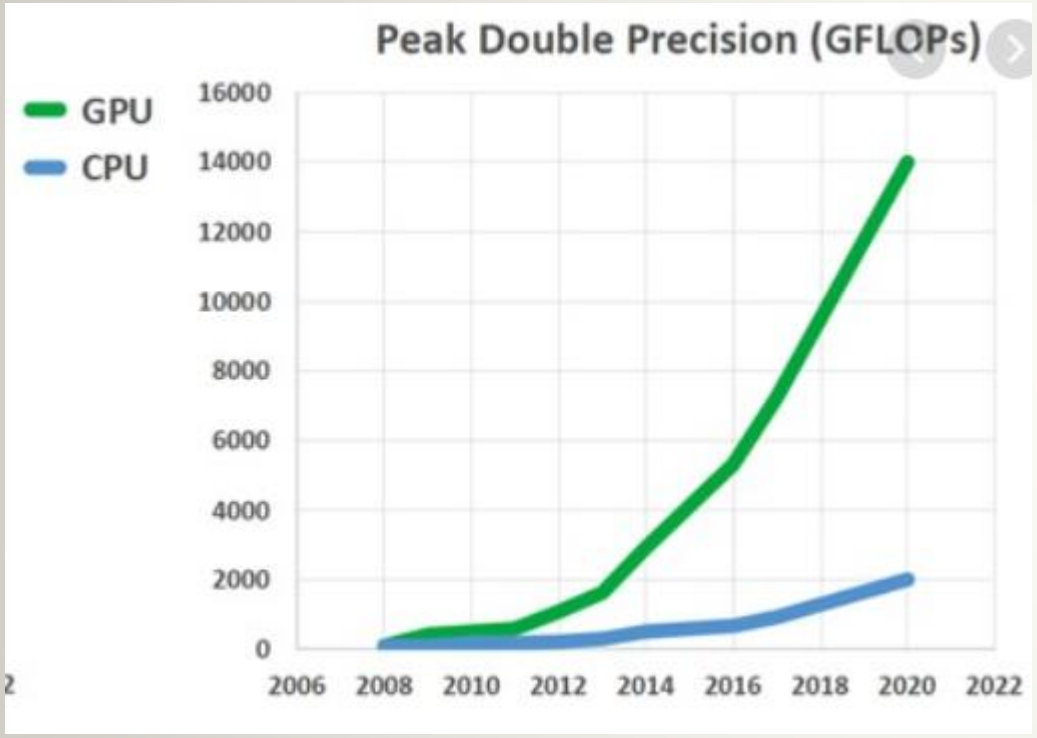


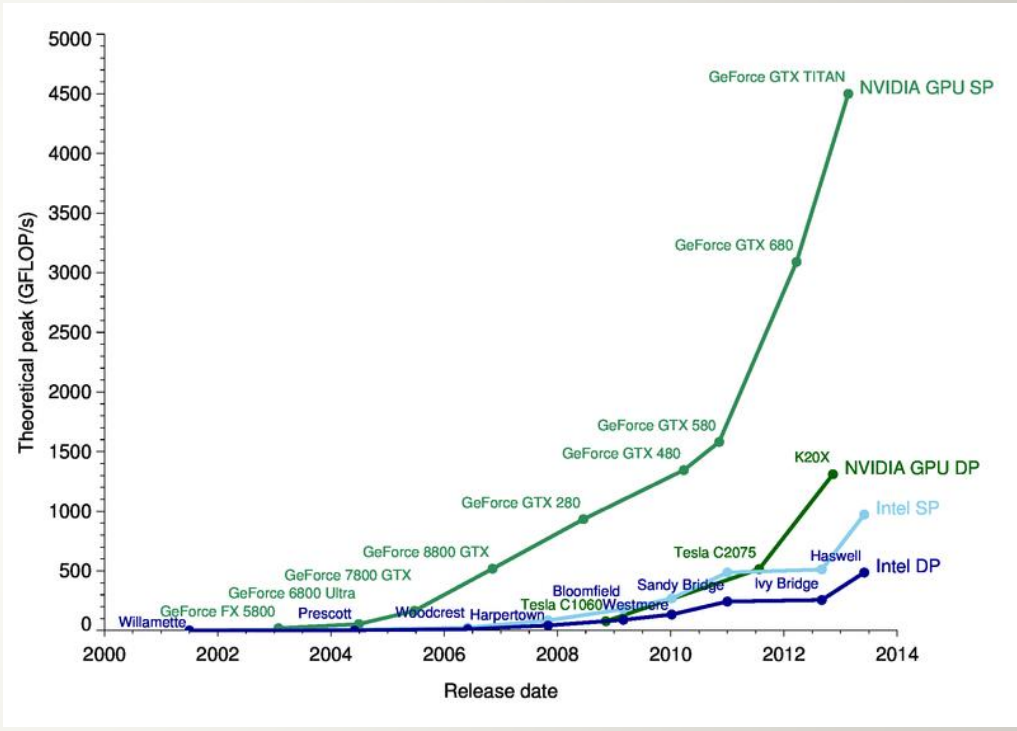


NVIDIA Tegra Family

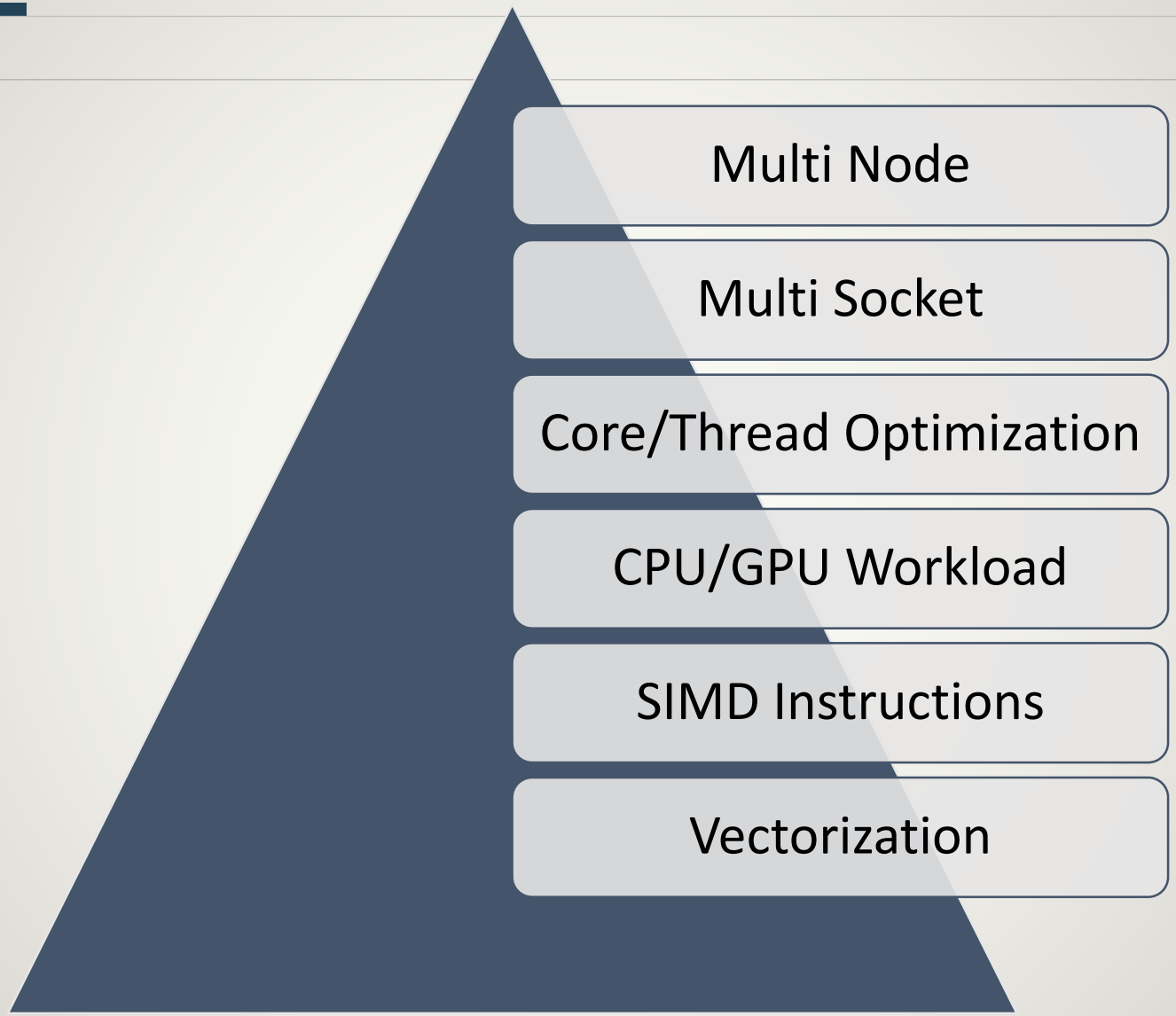
JETSON NANO	JETSON TX2 series (TX2, TX2 4GB, TX2i*)	**JETSON XAVIER NX**	JETSON AGX XAVIER series (AGX Xavier, Xavier ind.)
			
0.5 TFLOPS (FP16) 5-10W 45mm x 70mm $129	1.3 TFLOPS (FP16) 7.5-15W 50mm x 87mm Starting at $249	**6 TFLOPS (FP16) | 21 TOPS (INT8)** **10-15W** **45mm x 70mm** **$399**	20-32 TOPS (INT8) 5.5-11 TFLOPS (FP16) 10-30W 100mm x 87mm Starting at $899

CPU vs. GPU - Trends



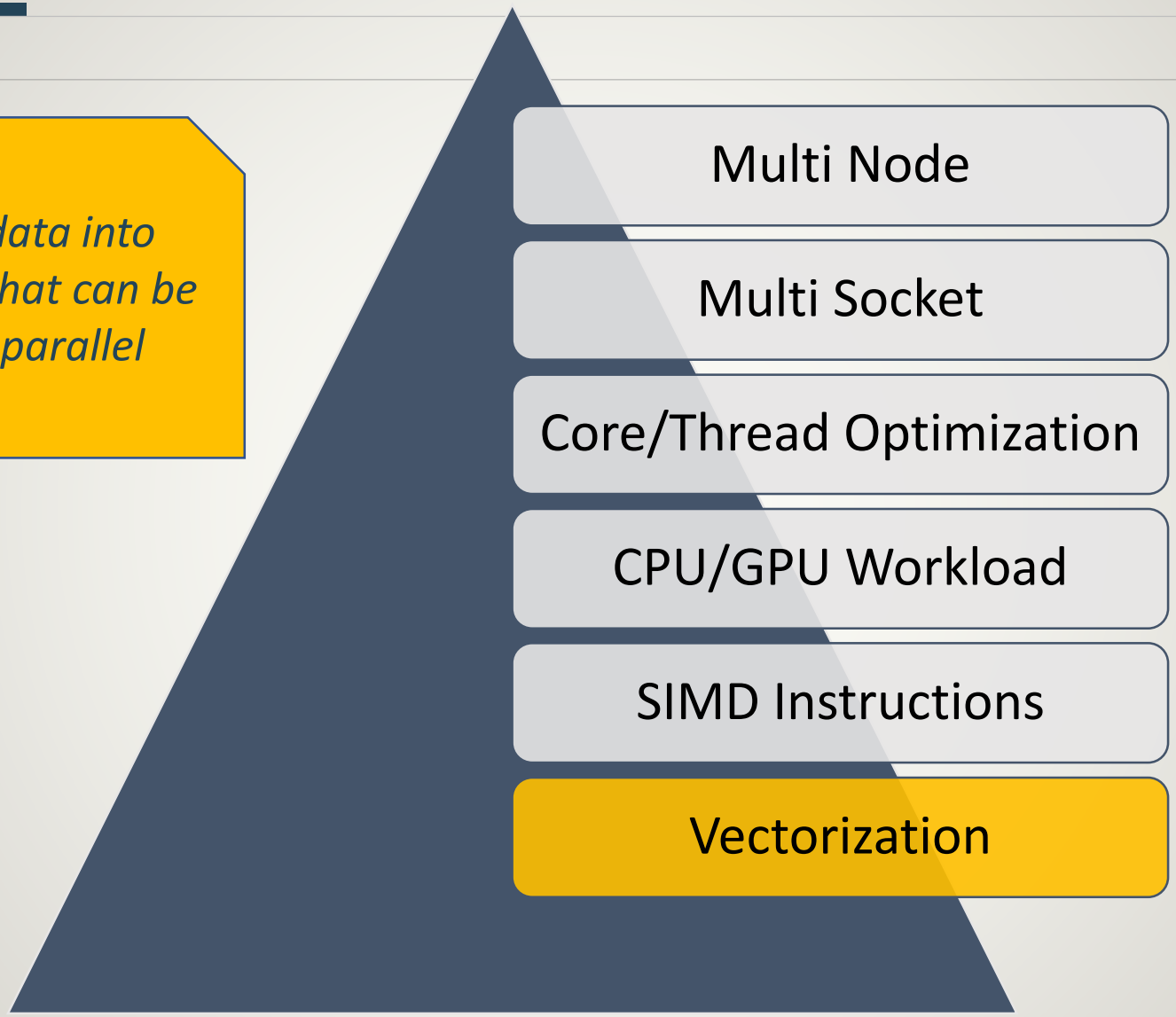


Seven Levels of Optimization



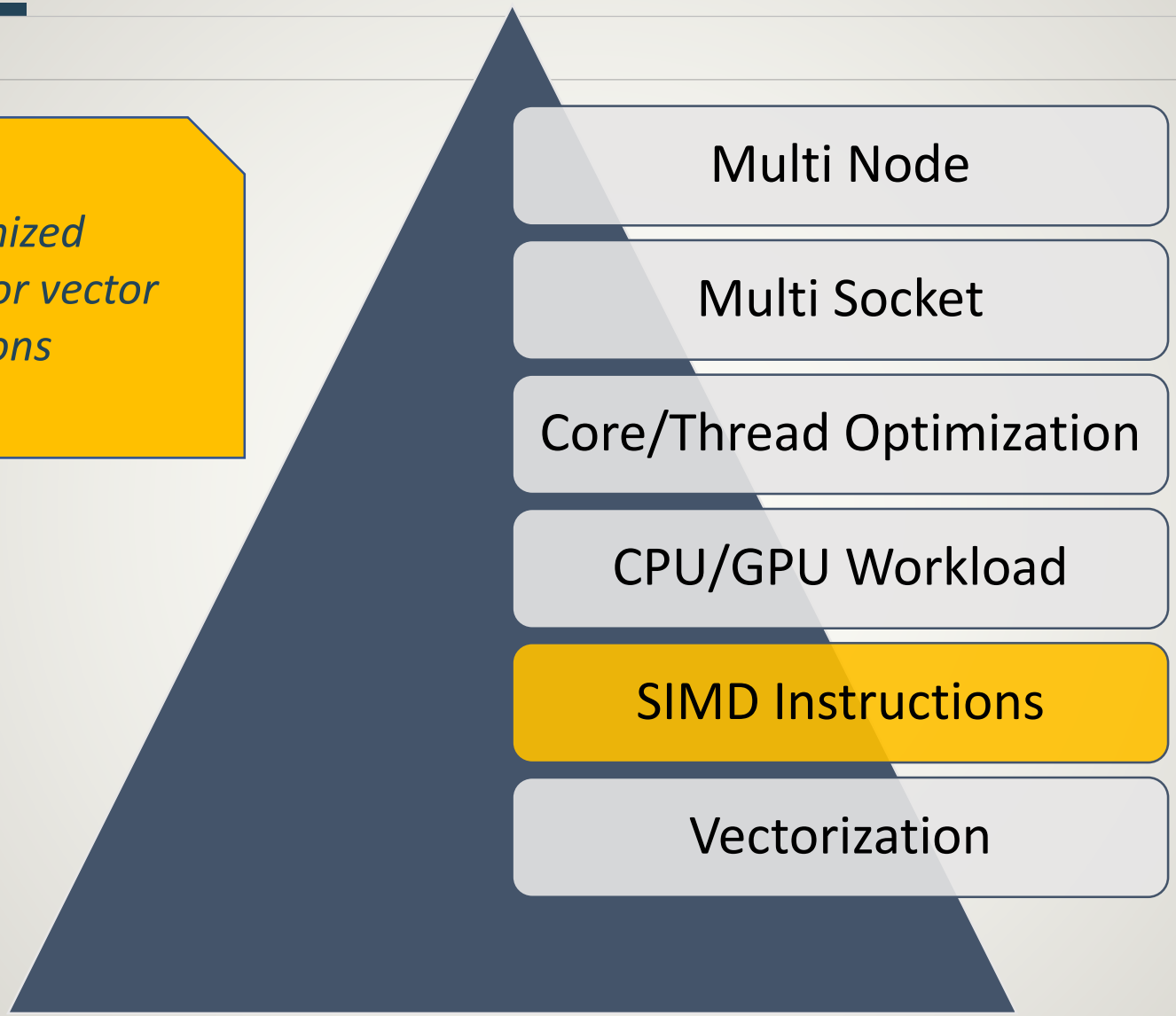
Seven Levels of Optimization

Dividing the data into smaller pieces that can be processed in parallel



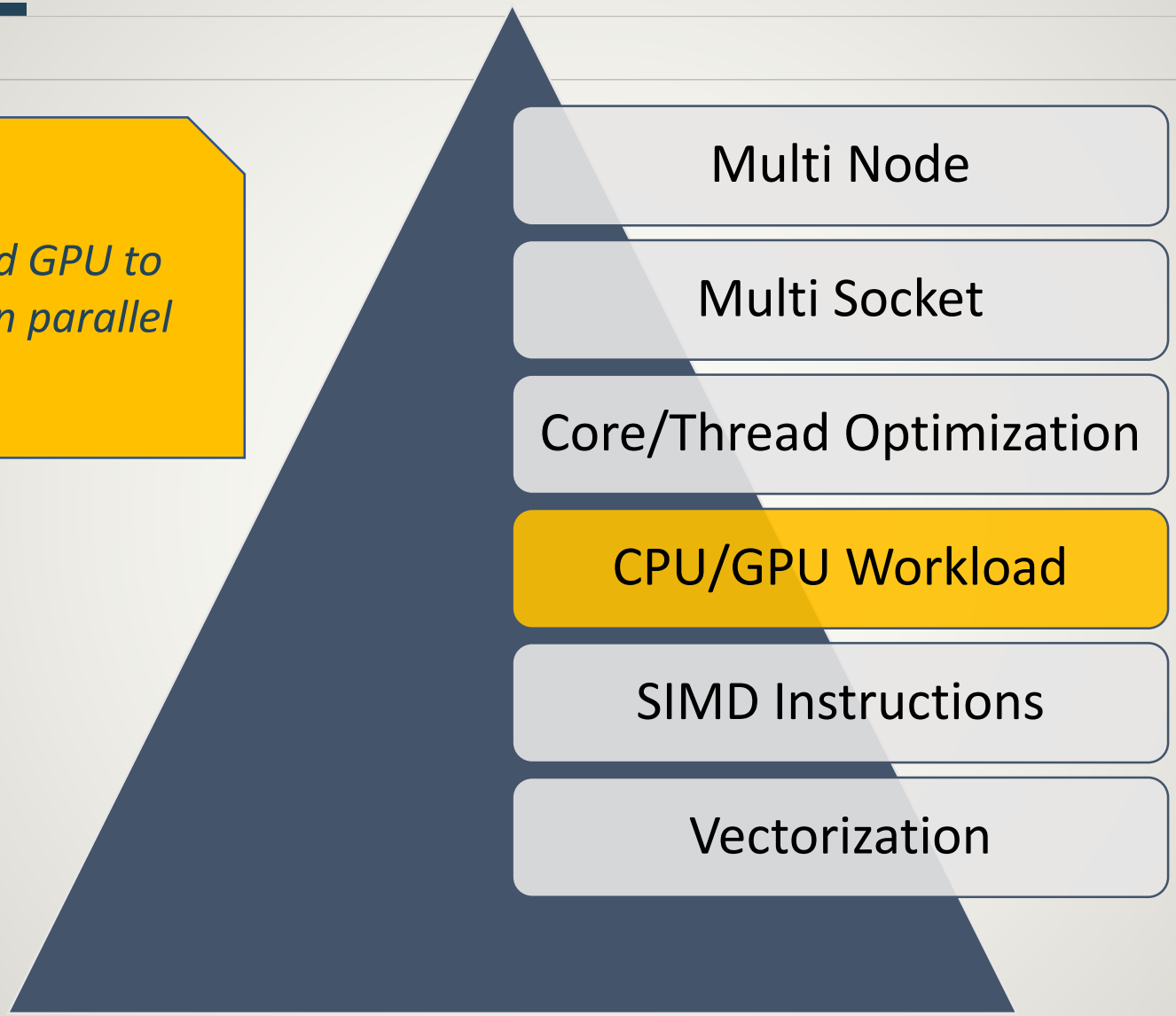
Seven Levels of Optimization

Use optimized instructions for vector operations



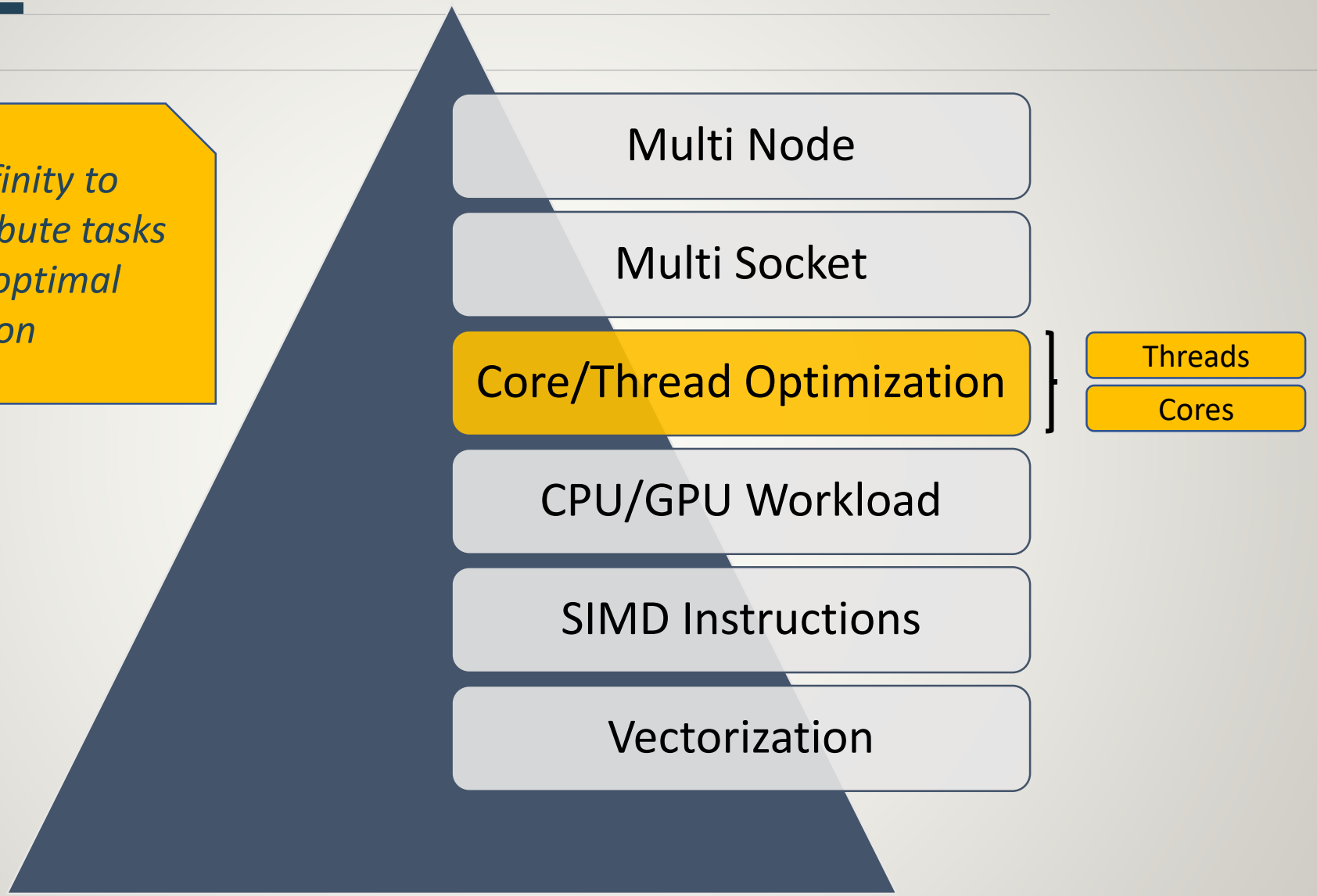
Seven Levels of Optimization

Make CPU and GPU to execute data in parallel



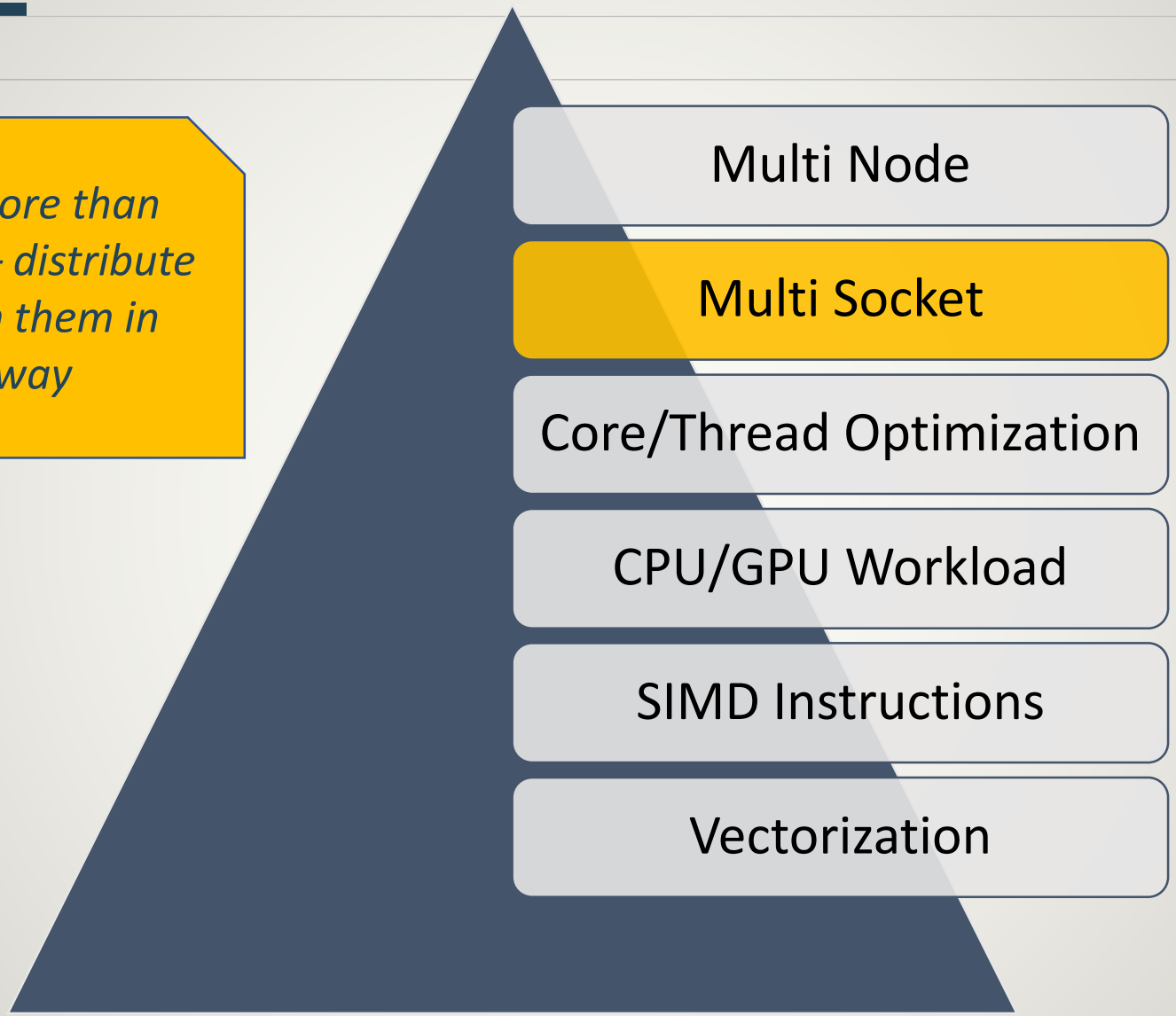
Seven Levels of Optimization

Use Core Affinity to manually distribute tasks to cores for optimal execution



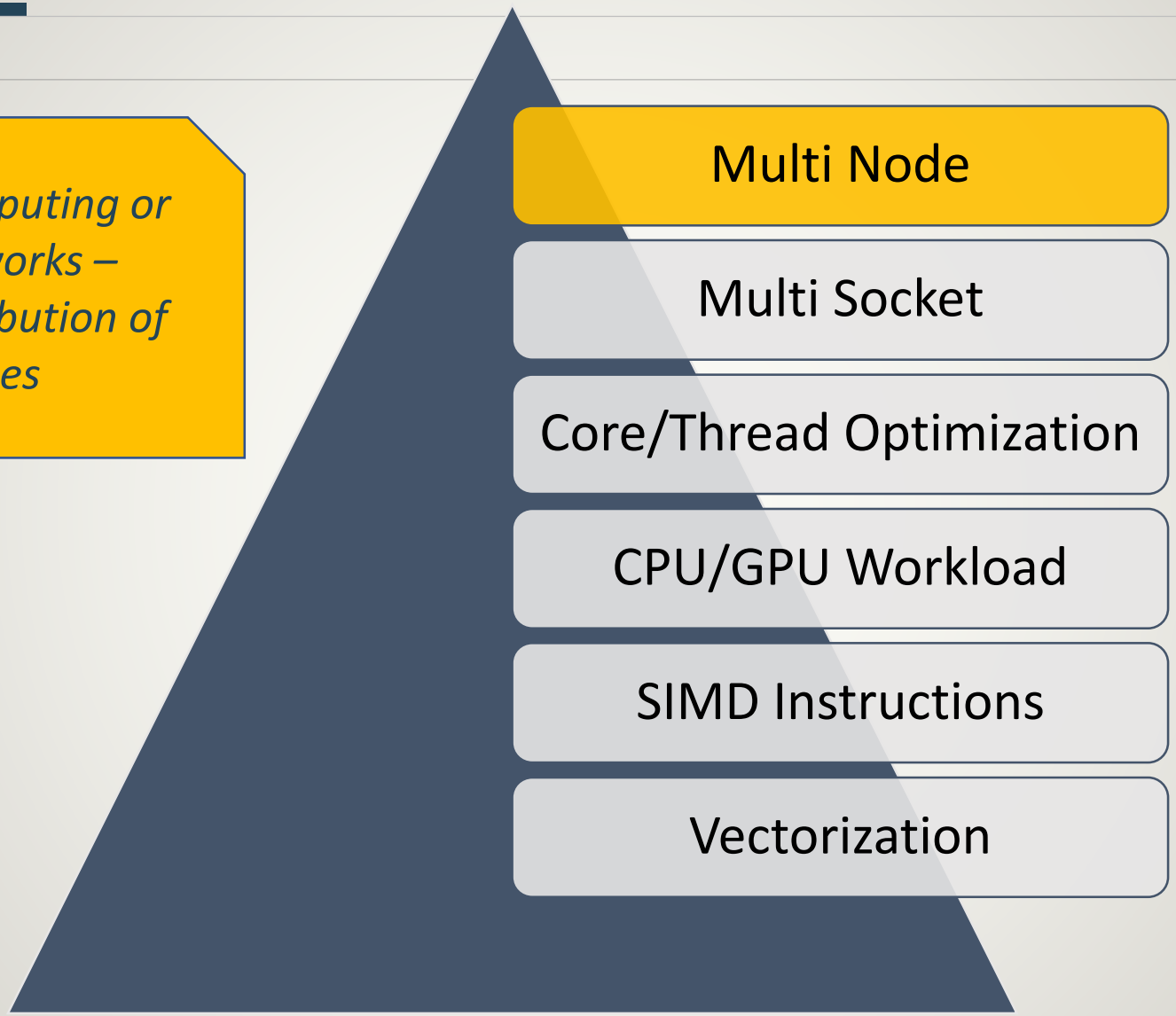
Seven Levels of Optimization

If there are more than one CPU/GPU – distribute data between them in efficient way

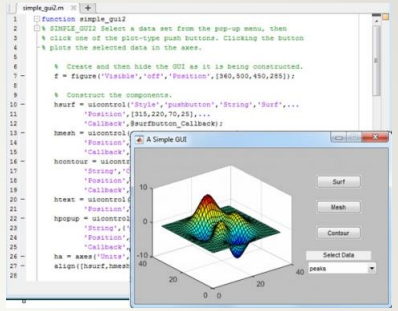


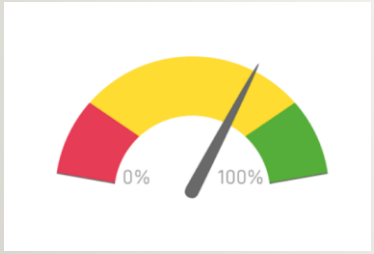
Seven Levels of Optimization

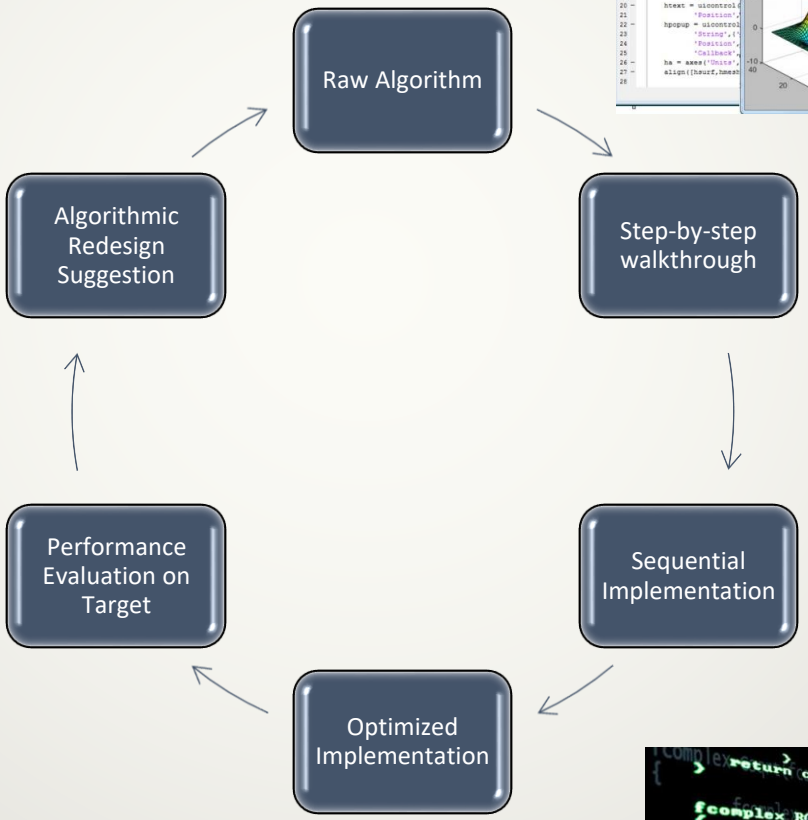
For cloud computing or larger networks – efficient distribution of resources



Algo-Software Design Flow







Algo-Software Design Flow

Software Requirements

RT/Embedded/Parallel Design

Implementation (C++)

End-to-end & Robustness Testing

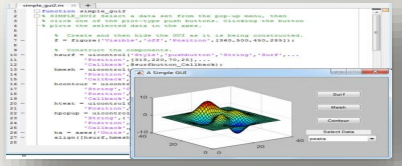
=

Literature Study

Algorithmic Design

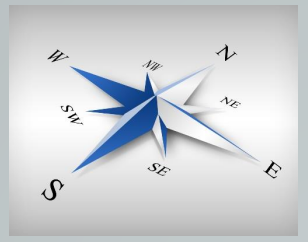
Implementation (Matlab/Python)

Operations Research

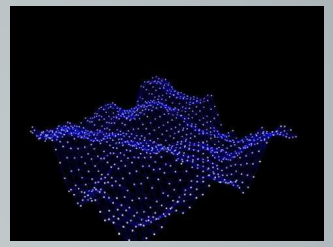


HPC Solutions

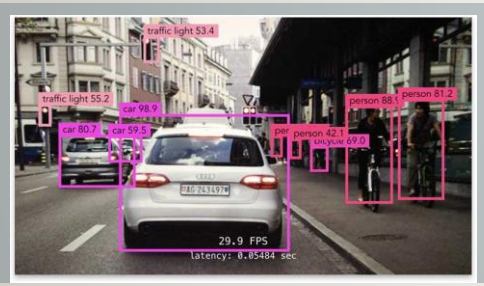
Image Processing



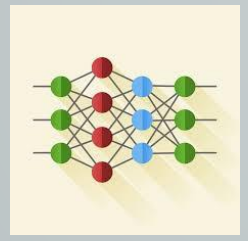
Sensor-based Navigation



3D Modelling



Object Detection & Tracking



Deep Learning Inference

Decision Making

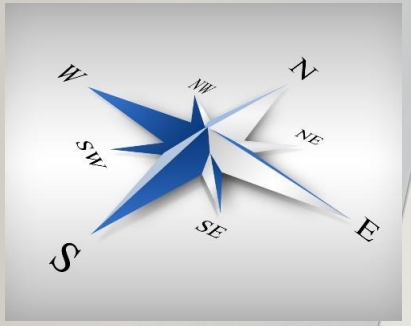
HPC Solutions

Image Processing

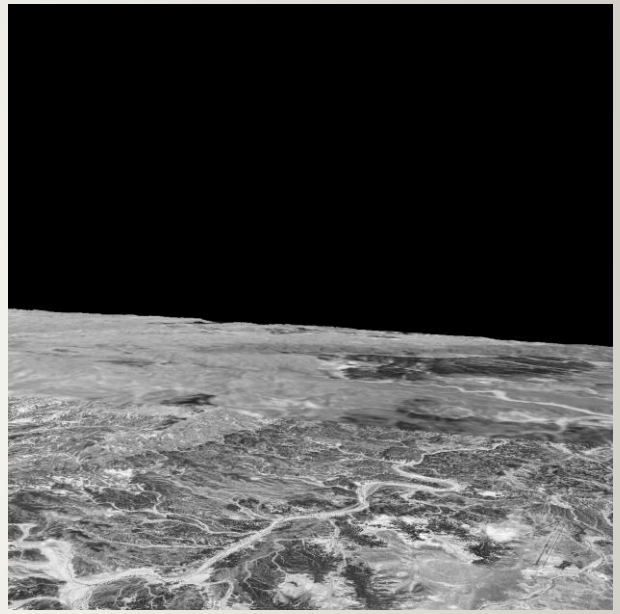
- Histogram Stretch
  - CLAHE
- Temporal Corrections
- Edge Detection
  - SOBEL
- Distortion Correction
  - Parallax
  - Gray Levels
- Image Stitching
- Color Transformations

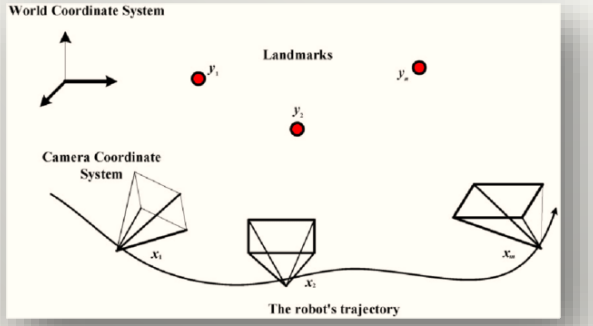
HPC Solutions

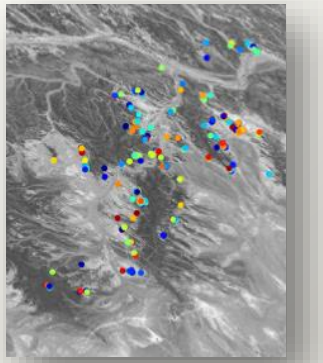
Sensor-based Navigation

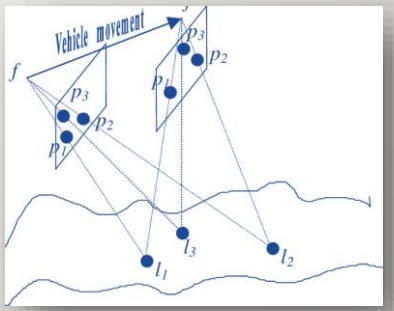


- Image-Map Registration
  - Non-linear Solver
  - RANSAC
  - FFT
- 2D SLAM
- 3D SLAM
- Terrain Registration
- Horizon Detection



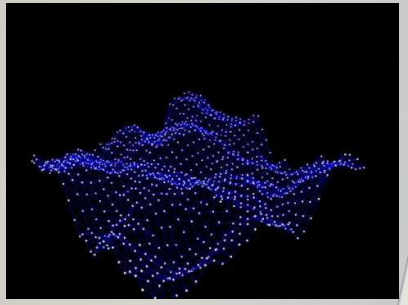




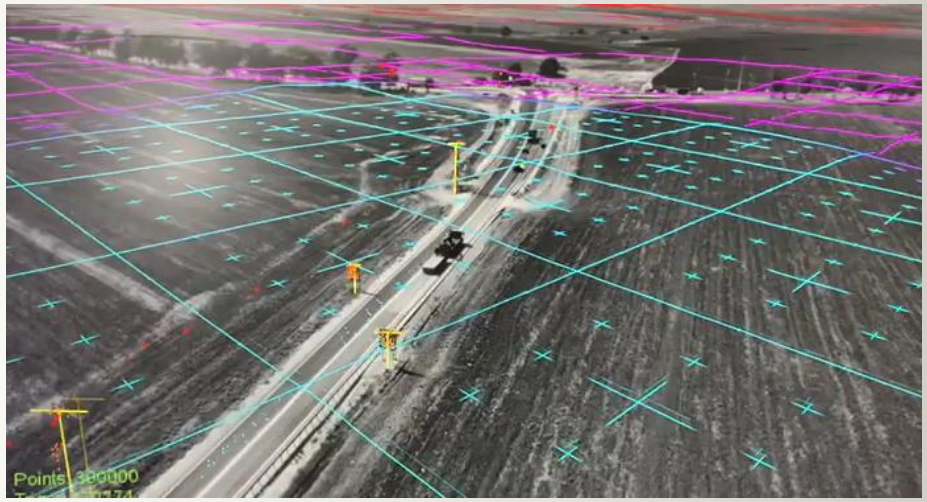


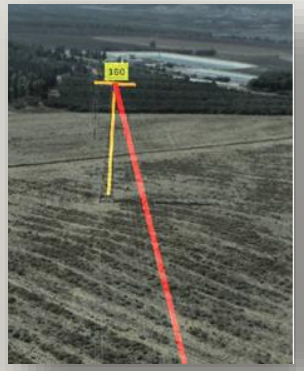
HPC Solutions

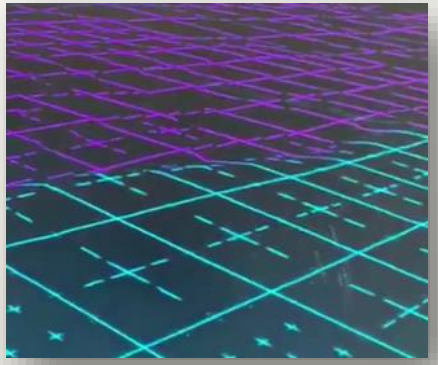
3D Modelling

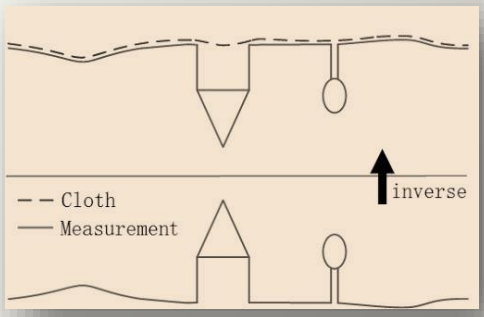


- Terrain Reconstruction (CSF)
- Objects Detection
- Objects Classification
- Noise Filtering
- Terrain Fusion



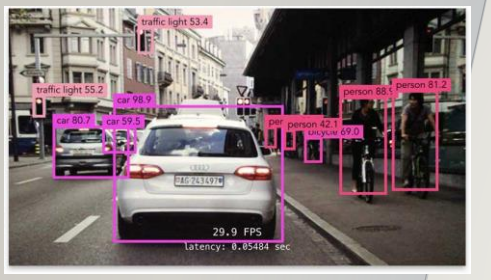






HPC Solutions

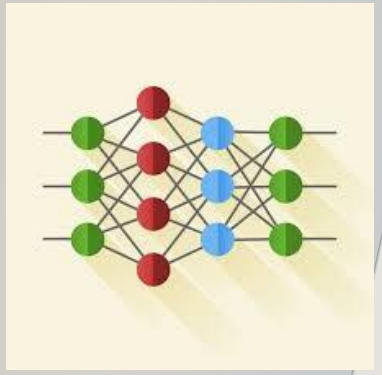
Object Detection & Tracking



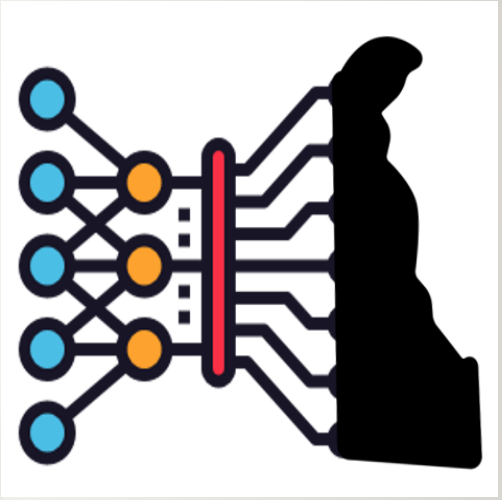
- Object Detection
  - Background Subtraction
  - Deep Learning (CNN)
- Tracking
  - Temporal Filter
  - Optical Flow
  - GFTT
  - Superglue/D2NET (CNN)c

HPC Solutions

Deep Learning Inference

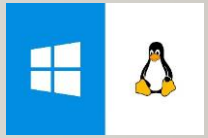


- Quantization Techniques
- Inference Framework
  - Cross-Platform
  - Cross-Framework
  - CPU/GPU/TPU/APU/FPGA
- Custom Layers



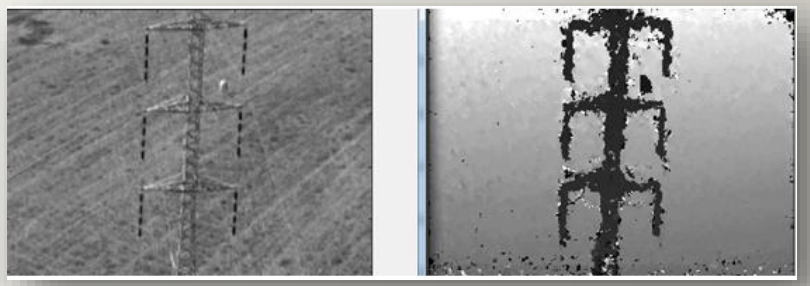
TensorFlow

PYTORCH



Super Resolution

GAN



Depth Reconstruction