MODULE 2: AI HARDWARE & PROCESSORS

2.1 Importance of AI Hardware

AI hardware is the physical foundation that makes intelligent systems possible. Advanced hardware directly improves AI efficiency, speed, and capability.

🚀 **AI Hardware Accelerates:**

- Data processing at massive scale
- AI model training (reducing days to hours)
- Real-time decision-making
- Intelligent application performance

2.2 CPU — Central Processing Unit

The CPU is the "brain of the computer." It controls and manages all system operations and coordinates other components.

Core Functions of a CPU

- Fetching instructions from memory
- Performing arithmetic and logical calculations
- Managing and coordinating operations
- Storing results back to memory

✅ Advantages	⚠️ Limitations
Versatile — handles many task types	Slower for AI model training
Reliable and well-tested technology	Limited parallel processing capability
Handles multiple general tasks	

2.3 GPU — Graphics Processing Unit

GPUs are the backbone of modern AI systems. Unlike CPUs that process tasks one at a time, GPUs perform thousands of calculations simultaneously through parallel processing.

GPU Applications in AI

- Deep learning model training
- Image and video recognition
- Neural network training
- Natural language processing

⚡ **Key Benefit**

Training time that takes weeks on a CPU can be reduced to hours on a GPU. NVIDIA is the leading GPU manufacturer for AI.

2.4 TPU — Tensor Processing Unit

TPUs are specialized processors designed specifically for Machine Learning and AI tasks. Developed by Google, TPUs are highly efficient for tensor (multi-dimensional data) operations.

TPU Applications

- Neural network training at scale
- Natural Language Processing (NLP)
- Large recommendation systems
- Image recognition pipelines

TPU Advantages

- Significantly faster AI computation than CPUs
- Lower power consumption per computation
- Highly optimized specifically for AI workloads

2.5 NPU — Neural Processing Unit

NPUs are low-power AI chips found in smartphones and smart devices. They bring AI capabilities directly to edge devices, enabling on-device intelligence without needing the cloud.

NPU Applications

- Face unlock on smartphones
- Voice assistant processing
- Camera enhancement and night mode
- Real-time translation

NPU Benefits

- **Faster response** — no server round-trip needed
- Works offline without internet connection
- **Better privacy** — data stays on device
- Lower power usage, extending battery life

2.6 Comparison of AI Processors

Processor	Full Name	Main Purpose	Best Use Case
CPU	Central Processing Unit	General computing	System control & everyday tasks
GPU	Graphics Processing Unit	Parallel processing	AI training & deep learning
TPU	Tensor Processing Unit	AI optimization	Large-scale machine learning
NPU	Neural Processing Unit	Edge AI	Mobile & IoT devices

🧠 **Memory Aid**

CPU = Control | GPU = Graphics / Parallel | TPU = Tensor / Training | NPU = Neural / No-cloud

Each processor is designed for a specific role in the AI pipeline.