

NVIDIA Jetson 边缘 AI 计算 平台

NVIDIA Jetson 是专为边缘 AI 运算设计的嵌入式平台，支持 **CUDA**、**TensorRT** 等 GPU 加速技术，能执行深度学习模型与视觉推论。本演示将介绍 **Jetson** 系列产品、边缘 AI 计算的重要性以及其典型应用场景，特别关注 **Jetson Orin Nano** 在教育和实际应用中的潜力。



投稿人: *Kunta Hsieh*

Jetson 系列产品概览



Jetson Nano

适合教学与低功耗应用的入门级平台，计算能力达 **0.5 TFLOPs**，是学习 **AI** 和开发原型的理想选择。价格亲民，功耗低，适合初学者和小型项目。



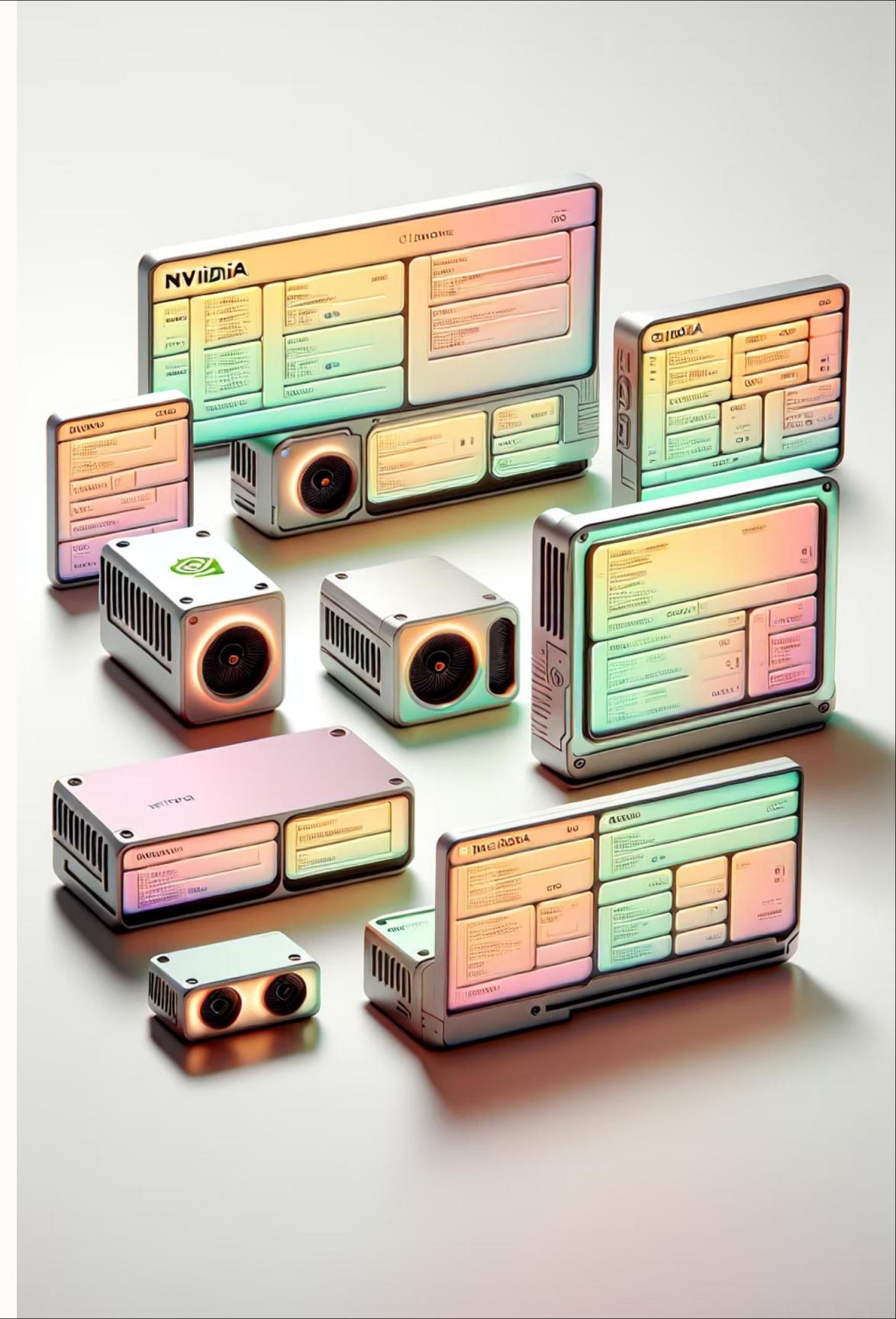
Jetson Xavier NX

面向中高阶应用，如自驾车、机器人等场景，计算性能达 **21 TOPS**。提供更强大的处理能力，满足复杂 **AI** 模型的需求，同时保持较小的体积。



Jetson Orin Nano

高效能 **AI** 边缘应用平台，性能最高可达 **40 TOPS**，整合 **Ampere** 架构，支持 **CUDA 11** 与 **TensorRT 8**，是目前系列中性能最强大的产品。



Specification	Original	Super
GPU Speed	635 MHz	1020 MHz
AI Performance (Sparse)	40 TOPS	67 TOPS
AI Performance (Dense)	20 TOPS	33 TOPS
CPU Speed	1.5 GHz	1.7 GHz
Memory Bandwidth	68 GB/s	102 GB/s
Power Modes	7W 15W	7W 15W 25W

LLM

Large Language Model

- Understands **text and language**
- Generates **human-like responses**
- ChatGPT, Gemini, CoPilot**

VLM

Vision Language Model

- Processes both **images and text**
- Image Captioning**
- Text-to-Image generation**

ViTs

Vision Transformers

- Image Recognition Neural Network**
- Image Classification and Detection**
- Medical Imaging, Self-Driving Cars**

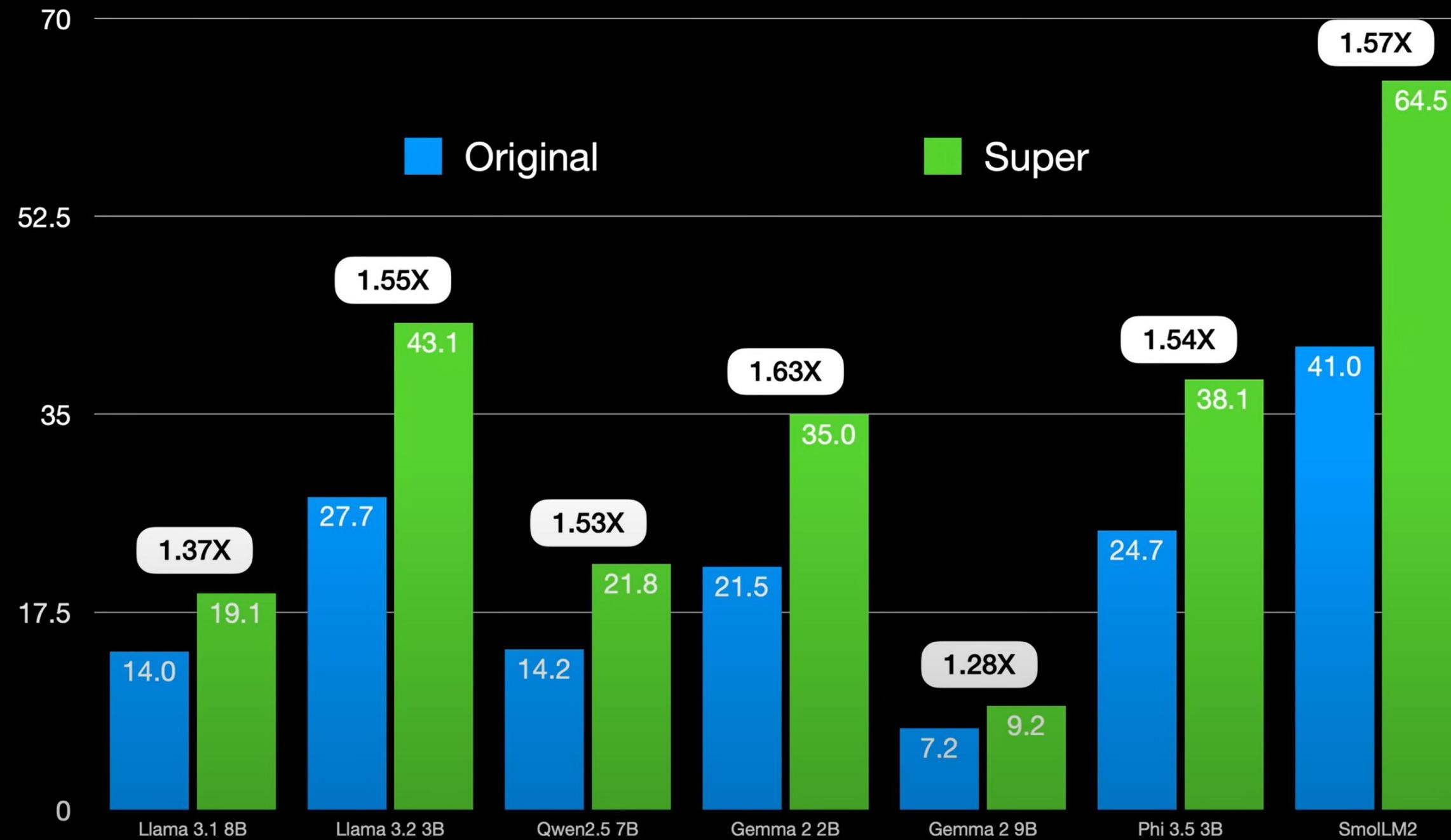
NVIDIA “Super” Update

1.7X AI Performance Gain

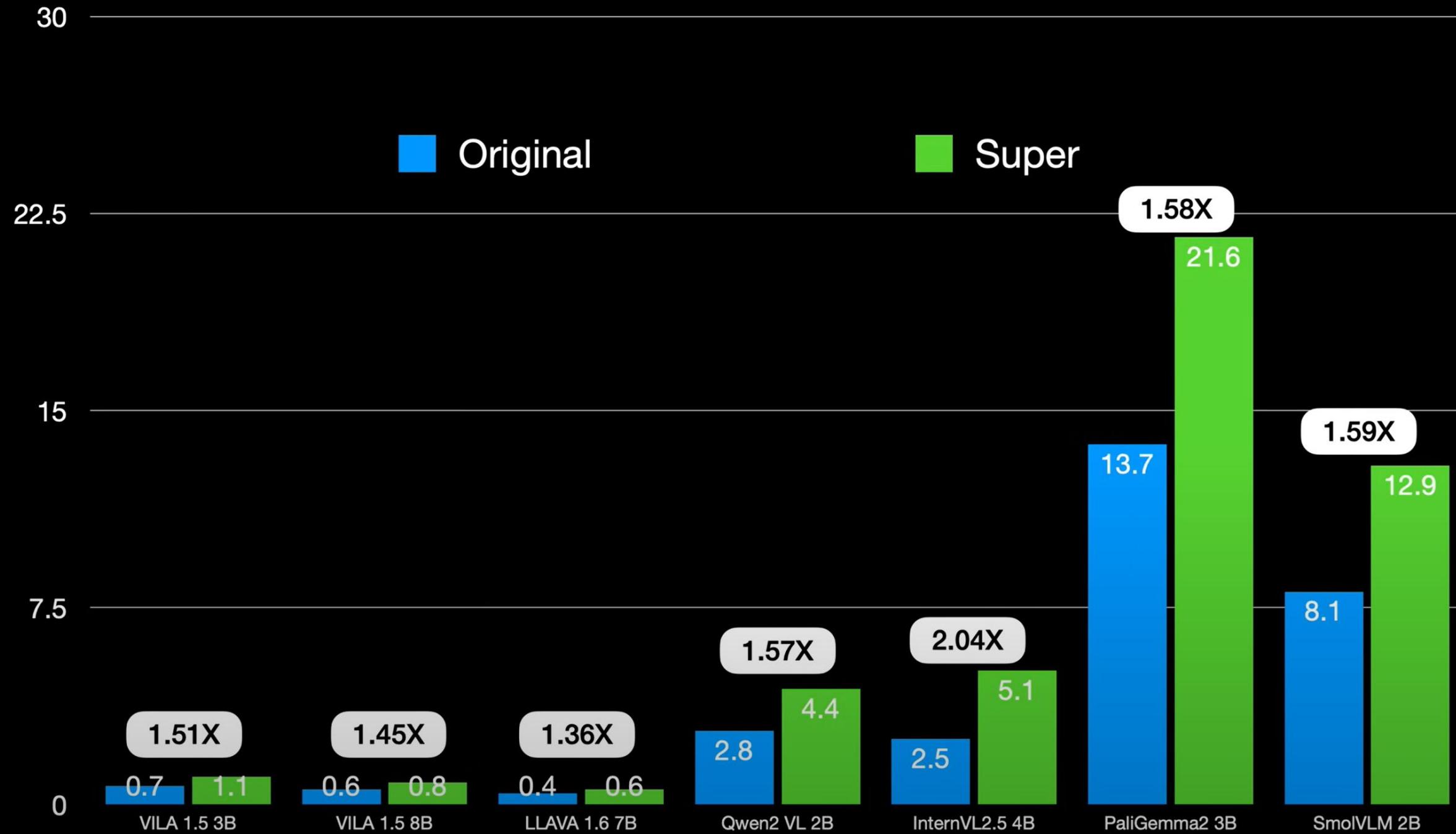
1.5X Memory Bandwidth

New 25 Watt Mode

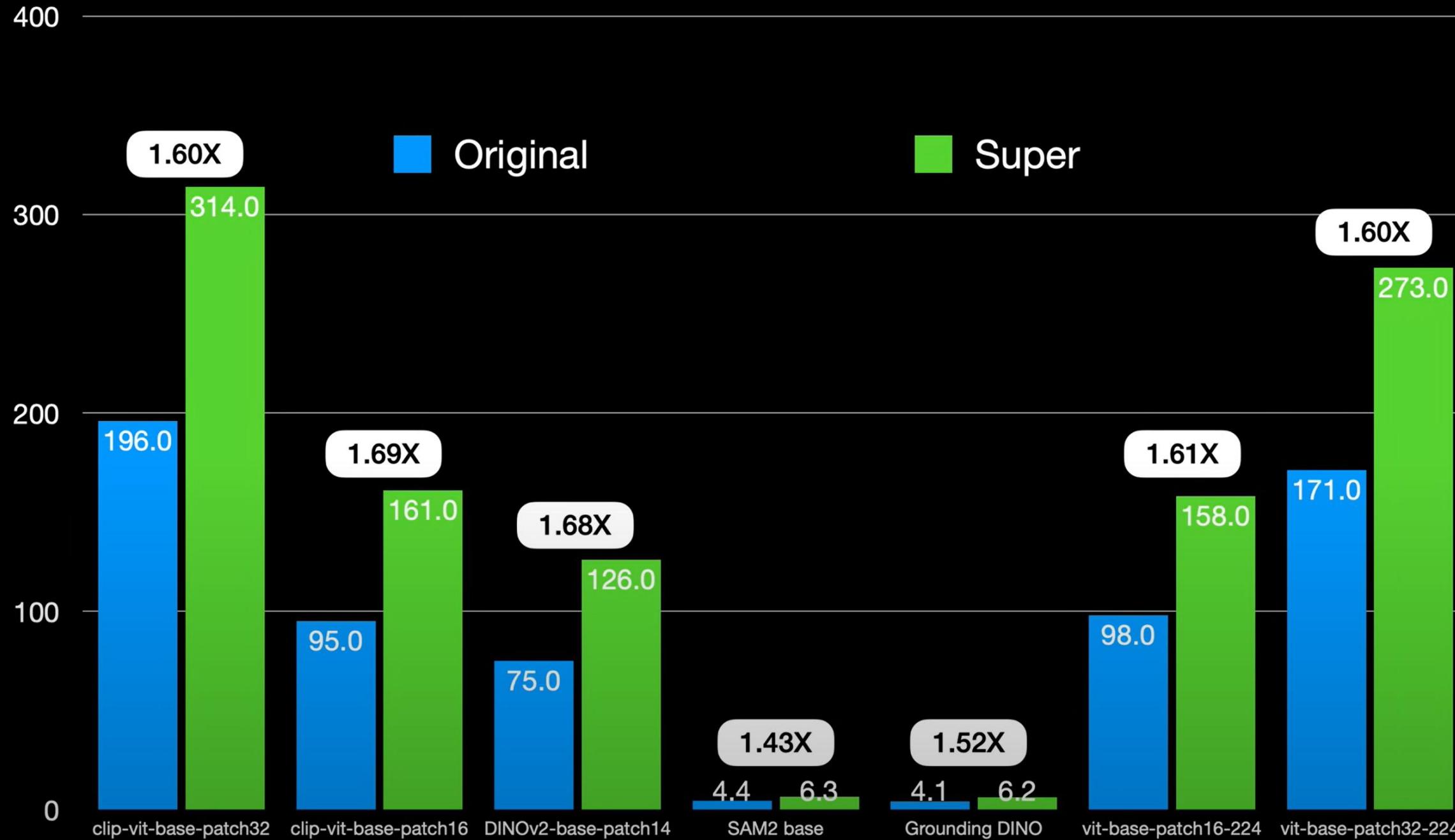
LLM Performance



VLM Performance



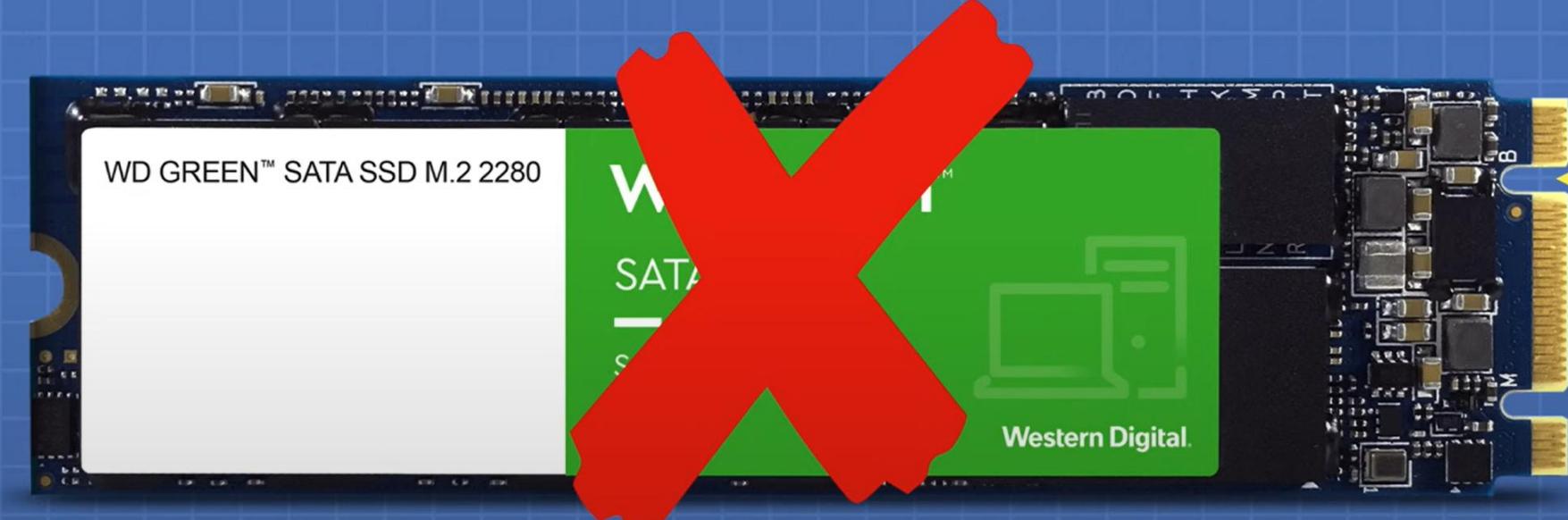
ViTs Performance



Solid State Drives



NVMe PCIe



2nd Notch
SATA

128GB

SDXC

SDXC Card - 64GB or Higher

Class 10, UHS-1, V30 or Better

Read Speed: 90MB/s or Better

Write Speed: 50MB/s or Better

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JetPack SDK

NVIDIA JetPack SDK powering the Jetson modules is the most comprehensive solution for building end-to-end accelerated AI applications, significantly reducing time to market.

NVIDIA JetPack includes 3 components:

Jetson Linux: A Board Support Package (BSP) with bootloader, Linux kernel, Ubuntu desktop environment, NVIDIA drivers, toolchain and more. It also includes security and Over-The-Air (OTA) features.

Jetson AI Stack: CUDA Accelerated AI stack which includes a complete set of libraries for acceleration of GPU computing, multimedia, graphics, and computer vision. It supports application frameworks such as [Metropolis](#) to build, deploy and scale Vision AI application, [Isaac](#) for building high performance robotic applications and [Holoscan](#) for building high performance computing applications (HPC) with real time insights and sensor processing capabilities from edge to cloud.

Installing JetPack

SD Card Image Method for Jetson Orin Nano Developer Kit

FOR JETSON ORIN NANO DEVELOPER KIT CURRENTLY RUNNING JETPACK

6.X

[Download JetPack 6.2 SD card image for Jetson Orin Nano Developer Kit](#)

Follow the instructions provided in [Getting Started Guide](#)

NVIDIA SDK Manager Method

FOR ANY JETSON ORIN DEVELOPER KIT

FOR OTHER JETSON ORIN NANO DEVELOPER KIT (FRESH UNBOXED UNIT

OR EXISTING UNIT CURRENTLY RUNNING JETPACK 5.X)

The factory-installed firmware on the Jetson Orin Developer Kit supports JetPack 5.x and requires an update to ensure compatibility with JetPack 6.x.

Update the firmware by following the instructions in the [Initial Setup Guide for Jetson Orin Nano Developer Kit](#) before installing JetPack 6.2.

SSD Installation

The screenshot shows a web browser displaying the NVIDIA Developer website at developer.nvidia.com/sdk-manager. The page title is "SSD Installation". The main content area features a large section titled "SDK Manager" with a sub-section "Everything You Need to Set Up Your Development Environment". Below this, there is a paragraph about the SDK Manager's purpose and a "Download NVIDIA SDK Manager 2.2.0" section with download links for various operating systems and Docker images. At the bottom, there are sections for "NVIDIA Cloud" and "SDK Packages".

SDK Manager

Everything You Need to Set Up Your Development Environment

NVIDIA SDK Manager provides an end-to-end development environment setup solution for NVIDIA's Jetson, Holoscan, Rivermax, DeepStream, GXF Runtime, Aerial Research Cloud (ARC-OTA), Ethernet Switch, RAPIDS, DRIVE and DOCA SDKs for both host and target devices.

Download NVIDIA SDK Manager 2.2.0

	.deb Ubuntu
	.rpm CentOS/RHEL
	Docker Image Ubuntu 18.04
	Docker Image Ubuntu 20.04
	Docker Image Ubuntu 22.04

[SDK Manager User Guide](#)

NVIDIA Cloud

SDK Packages

DEVELOPMENT ENVIRONMENT
NVIDIA SDK Manager development environment setup solution

NVIDIA SDK Manager

Prototype, fine-tune, and inference large AI models with the NVIDIA Project DIGITS personal AI supercomputer.

[Learn More](#)

JetPack SDK

<https://developer.nvidia.com/embedded/jetpack>

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Download Image

- Download JetPack Image from NVIDIA
- Burn to MicroSD on workstation
- Insert MicroSD in Jetson Orin Module
- Boot & follow setup procedure

Download Image

NVIDIA SDK Manager

- Download JetPack Image from NVIDIA
- Burn to MicroSD on workstation
- Insert MicroSD in Jetson Orin Module
- Boot & follow setup procedure

- Install SDK Manager on Ubuntu 22.04
- Insert MicroSD in Jetson Orin Module
- Put Jetson Orin Nano into “Recovery Mode”
- Connect via USBC to Ubuntu workstation
- Download JetPack files
- Set target to MicroSD and flash
- Power down Jetson & remove jumper
- Boot and follow setup procedure

```
jtop 4.3.2 - (c) 2024, Raffaello Bonghi [raffaello@rnext.it]
Website: https://rnext.it/jetson_stats
```

Platform

Machine: aarch64

System: Linux

Distribution: Ubuntu 22.04 Jammy Jellyfish

Release: 5.15.148-tegra

Python: 3.10.12

Libraries

CUDA: 12.6.68

cuDNN: 9.3.0.75

TensorRT: 10.3.0.30

VPI: 3.2.4

OpenCV: 4.8.0 with CUDA: NO

Serial Number: [s|XX CLICK TO READ XXX]

Hardware

Model: NVIDIA Jetson Orin NX Engineering Reference Developer Kit Super

699-level Part Number: 699-13767-0000-301 G.1

P-Number: p3767-0000

Module: NVIDIA Jetson Orin NX (16GB ram)

SoC: tegra234

CUDA Arch BIN: 8.7

L4T: 36.4.3

Jetpack: 6.2

Hostname: jetson

Interfaces

w1P1p1s0: 192.168.171.57

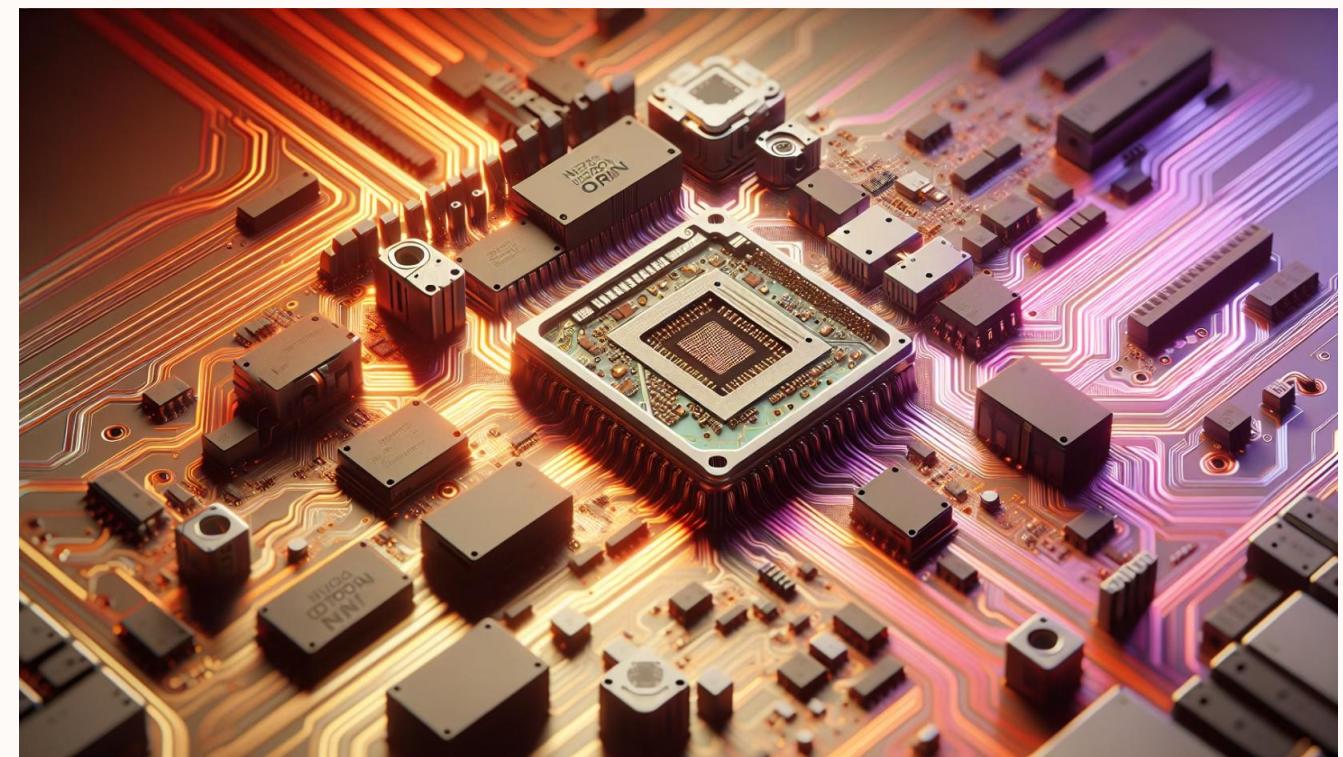
enP8p1s0: 192.168.0.106

l4tbr0: 192.168.55.1

Jetson Orin Nano 深入解析

Jetson Orin Nano 作为 **NVIDIA** 最新推出的边缘 **AI** 计算平台，集成了多项先进技术：

- 基于 **Ampere** 架构的 **GPU**，支持最新 **CUDA 11**
- 兼容 **TensorRT 8** 优化框架，加速深度学习推理
- 最高可达 **40 TOPS** 的 **AI** 性能，远超前代产品
- 低功耗设计，适合长时间运行的边缘设备
- 丰富的 **I/O** 接口，便于连接各类传感器和设备



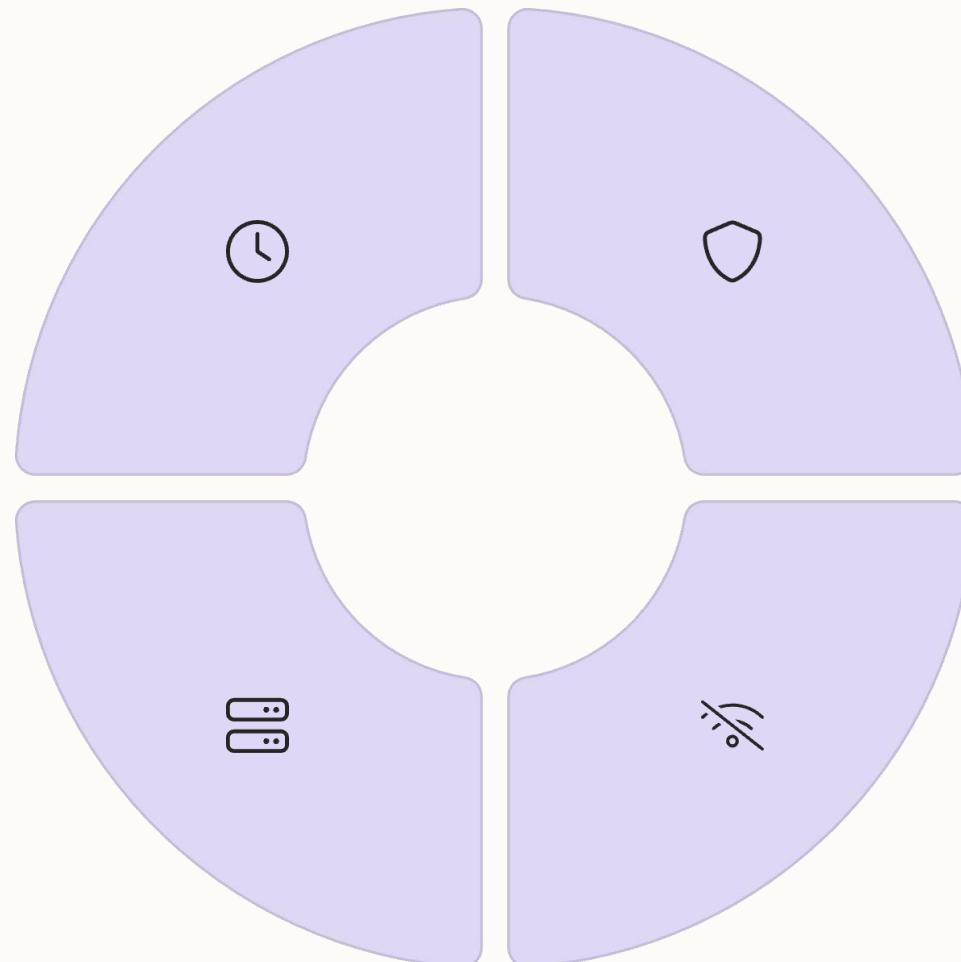
边缘 AI 计算的重要性

即时反应

适用于需要快速判断的应用场景，如自动驾驶、工业安全监控等。通过在本地处理数据，可以将响应时间从云端处理的数百毫秒缩短到几毫秒。

减轻带宽压力

仅传输处理结果而非原始数据，大幅降低网络带宽需求。对于视频分析等大数据量应用，可将传输需求降低 **90%** 以上，节省网络资源。



数据隐私

敏感数据在本地处理，无需上传云端，大幅降低隐私泄露风险。这对医疗、安防等领域尤为重要，符合各国日益严格的数据保护法规。

离线运行

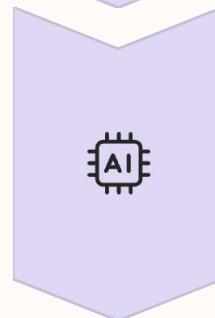
无需稳定网络连接即可独立运作，适合网络条件不佳的环境，如偏远地区、移动设备或网络受限的工业环境，确保系统持续可靠运行。

云端处理 vs 边缘计算



传统云端处理

数据从设备采集后需完整上传至云端服务器，经处理后再将结果返回设备。这种模式存在高延迟、高带宽消耗和潜在的隐私风险。



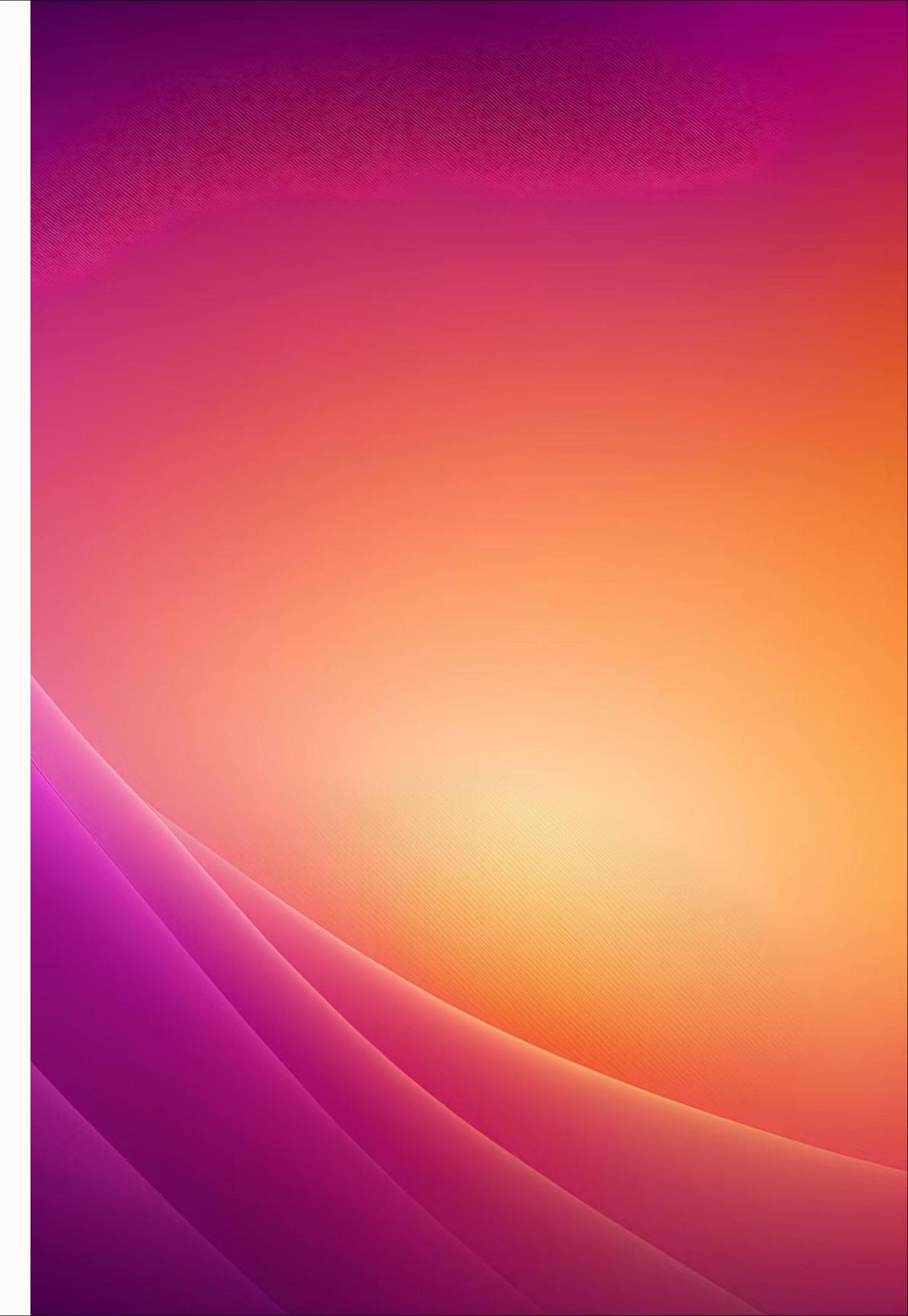
边缘 AI 计算

数据在采集点附近的边缘设备上直接处理，只将结果或必要信息传输至云端。这种方式大幅降低延迟，提高实时性，同时保护数据隐私。



混合架构优势

结合边缘计算的实时性和云端的强大计算能力，形成优势互补的混合架构。边缘处理紧急决策，云端负责复杂分析和模型更新。



智慧工厂应用场景

Jetson 平台在智慧工厂中的应用正在改变制造业的面貌：

- 产品瑕疵实时检测：通过高速摄像头和 **AI** 视觉分析，在生产线上实时识别产品缺陷，提高质检效率和准确率
- 机器异常监控：分析设备运行声音和振动数据，提前预测设备故障，实现预防性维护
- 生产线优化：通过分析生产流程数据，识别瓶颈环节，优化生产效率
- 工业机器人控制：为工业机器人提供实时视觉感知和决策能力，提高自动化水平

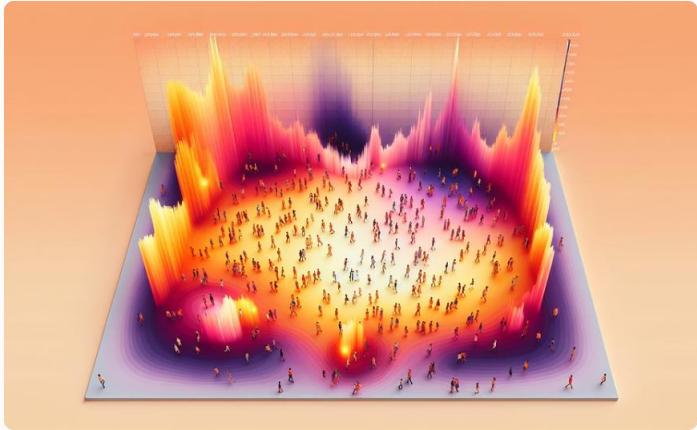


智慧安防应用场景



人脸识别系统

在公共场所入口处部署的 **Jetson** 驱动的安防系统可实时识别人脸，与数据库比对，提高安全管控能力。边缘处理确保识别过程快速且不依赖网络连接。



人流分析

通过分析摄像头捕捉的画面，统计人流量、识别异常行为和拥堵情况，为商场、车站等公共场所提供管理依据，同时保护个人隐私。



智能巡逻

搭载 **Jetson** 的安防机器人可自主巡逻，识别异常情况并发出警报。边缘 **AI** 使其能在无网络环境下持续工作，提供全天候安全保障。

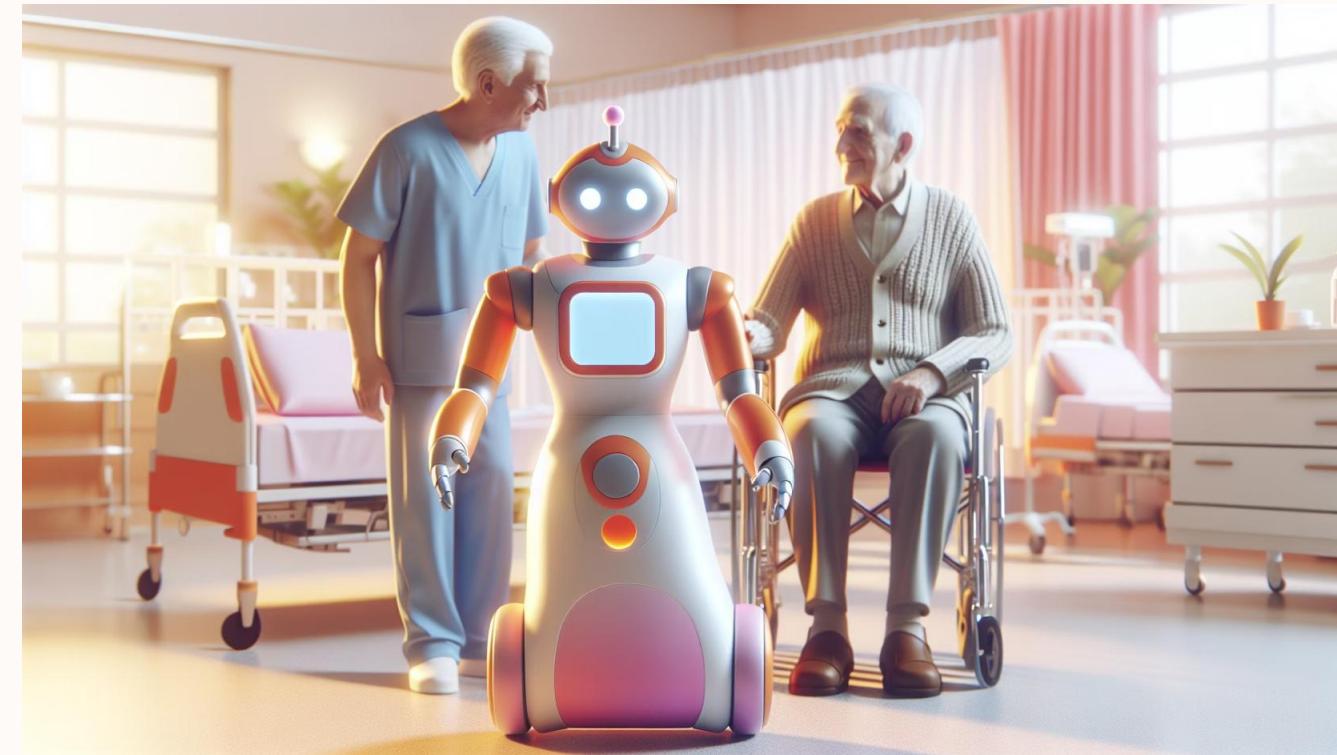
智慧医疗应用场景

病房监控与患者安全

Jetson 设备可实时分析病房摄像头画面，识别患者跌倒、异常行为或生命体征变化，及时通知医护人员。边缘处理确保患者隐私不被泄露。

AI 陪伴照护

搭载 **Jetson** 的智能机器人可为老年人或长期住院患者提供陪伴和基础照护，通过本地 **AI** 处理理解简单指令和情绪，减轻医护人员负担。



医学影像辅助诊断

在医疗设备端部署 **AI** 模型，可在采集医学影像的同时进行初步分析，标记可疑区域辅助医生诊断，提高效率并减少漏诊。



智慧交通应用场景

车流监控与分析

部署在交通要道的 **Jetson** 设备可实时分析车流量、车速和车型，为交通管理提供数据支持。边缘处理确保即使在网络中断情况下也能持续工作。

- 车牌自动识别系统，支持执法和停车场管理
- 车辆计数和分类，生成交通流量报告

交通信号优化

基于实时交通状况，智能调整信号灯时长，缓解拥堵，提高通行效率。系统可根据紧急车辆出现自动调整信号，确保救援车辆优先通行。

- 自适应信号控制系统，根据车流动态调整
- 紧急车辆优先通行机制

行人安全保障

在十字路口部署的 **AI** 系统可识别行人意图，预测可能的危险情况，通过警示系统提醒司机和行人，降低交通事故发生率。

- 行人意图预测系统
- 弱势群体（老人、儿童）特别保护机制

Jetson 平台的技术优势

40 TOPS 5-15W 1700+



AI 计算性能

Jetson Orin Nano 提供高达 **40 TOPS** 的 **AI** 计算能力，足以支持复杂的深度学习模型实时推理，满足视觉识别、自然语言处理等多种 **AI** 任务需求。

功耗范围

超低功耗设计使 **Jetson** 设备可在 **5-15W** 功耗范围内运行，适合电池供电的移动设备和需要长时间运行的边缘设备，大幅降低能源消耗。

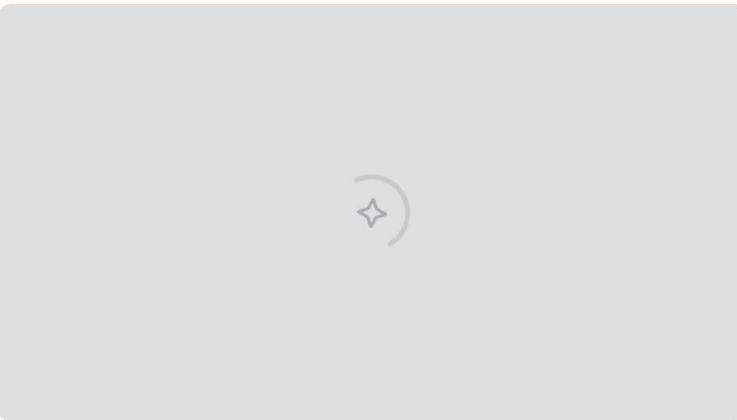
合作伙伴

NVIDIA 拥有超过 **1700** 家合作伙伴开发基于 **Jetson** 的解决方案，形成丰富的生态系统，为用户提供多样化的软硬件支持和行业解决方案。

教育领域的应用价值

Jetson 平台在教育领域具有独特价值，特别适合 **AI** 相关课程和跨学科项目：

- **AI 实验教学：** 提供实际硬件平台，让学生能够动手实践深度学习模型部署
- **跨领域专题开发：** 结合计算机视觉、机器人技术和特定领域知识，培养学生综合应用能力
- **创新创业项目：** 支持学生开发实际可用的 **AI** 应用原型，缩短从概念到产品的距离
- **科研支持：** 为高校研究提供高性能、低成本的 **AI** 计算平台，加速研究进程





总结与展望

当前成就

Jetson 系列，特别是 **Orin Nano**，已成为高效能、低功耗边缘 **AI** 计算的代表性平台，在工业、安防、医疗和交通等领域展现出巨大潜力。

教育价值

作为教学和实验的理想工具，**Jetson** 平台正帮助培养下一代 **AI** 人才，支持跨领域创新和实践项目开发，缩小理论与应用之间的差距。

未来发展

随着边缘 **AI** 技术不断进步，**Jetson** 平台将在更多领域发挥作用，推动智能化转型，创造新的应用可能，成为连接物理世界与数字智能的重要桥梁。

<https://github.com/jumbokh/JetsonNano-class>

The screenshot shows a GitHub repository page for 'JetsonNano-class'. The repository is public and has 1 branch and 0 tags. It contains 42 commits from the user 'jumbokh'. The commits are listed below:

File / Action	Description	Time Ago
docs	Add files via upload	22 minutes ago
images	add images	2 weeks ago
source	create xorg.conf	13 hours ago
README.md	Update README.md	39 minutes ago
class.md	Create class.md	26 minutes ago
developenv.md	Create developenv.md	13 hours ago
outline.md	Update outline.md	32 minutes ago
sometools.md	Create sometools.md	45 minutes ago