

Cloud Computing

Allgemeine Informatik - Sommersemester 2026



Architecture

Hardware and Network Architecture:

The cluster contains a Raspberry Pi 5 head node, eight Raspberry Pi 3 worker nodes, and a TP-Link switch
The switch edge ports use STP PortFast to prevent spanning tree delays during network boot

Centralized Storage and Boot Sequence:

The worker nodes perform network boots via local MicroSD cards that exclusively contain the firmware bootcode.bin
The head node uses DHCP, TFTP, and NFS to provide boot files and root filesystems from an external USB storage device
This architecture centralizes storage and eliminates the need for local operating system installations on the worker nodes

Remote Administration and Security:

The head node routes the internet traffic of the workers via Network Address Translation (NAT)
Tailscale is run on the head node to establish encrypted remote SSH access
This configuration isolates the worker nodes in a private network and prevents public internet sharing

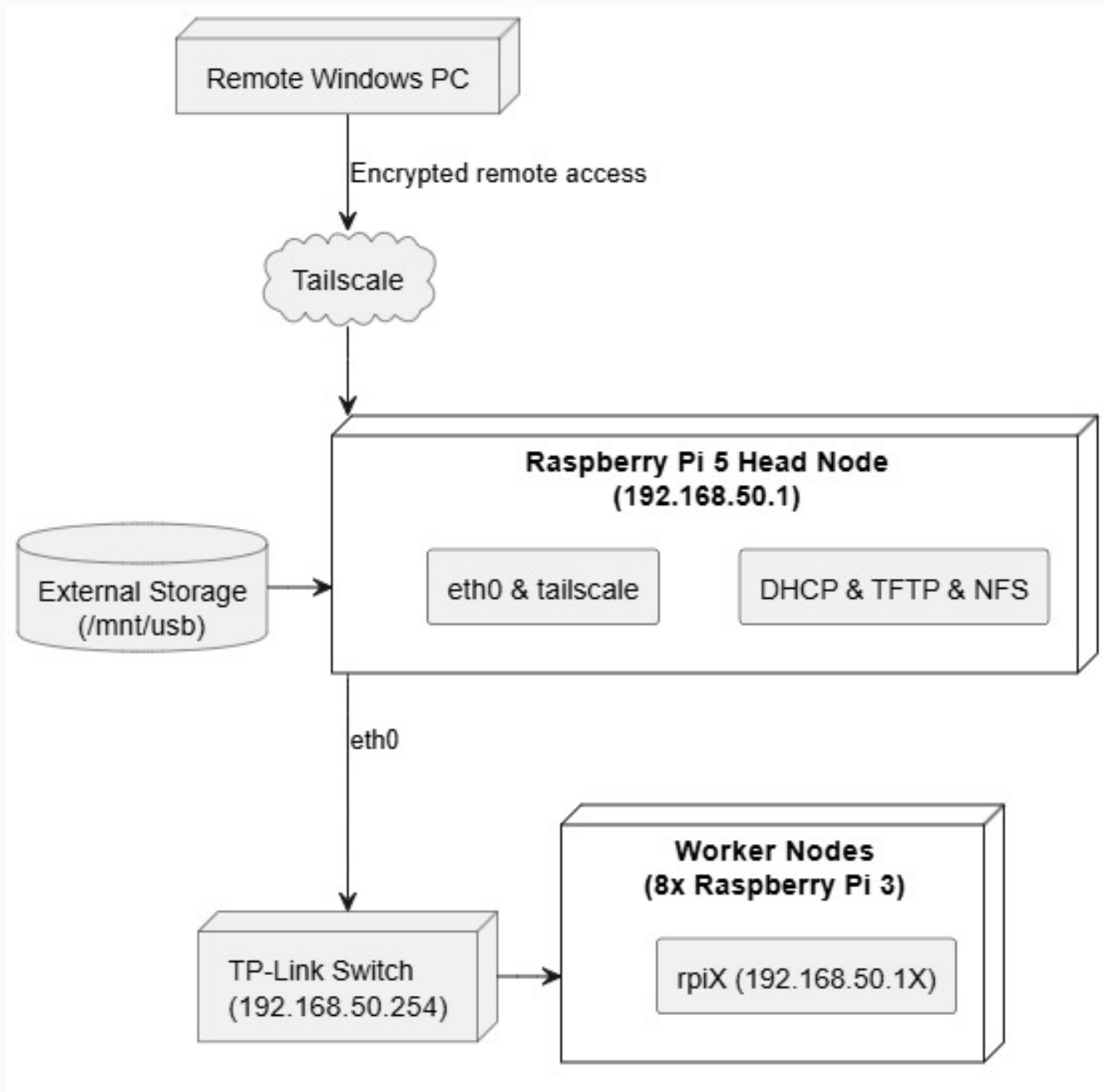


Figure 1:Architecture & Remotemanagement

Frontend & Backend

Backend (Docker Swarm Stack): FastAPI: REST interface for event processing and node management
PostgreSQL: Relational storage of event and node metadata
SeaweedFS: S3-compatible, distributed object storage for image data
Scalable deployment via manager and worker nodes in the Swarm cluster

Frontend (React Dashboard): Central visualization of threat events, camera status, and statistics
Flexible deployment as a Docker container (Nginx) or via Kubernetes (k3s)
API connection to the backend (default port 8000) with a configurable fetch interval

Benchmark Results

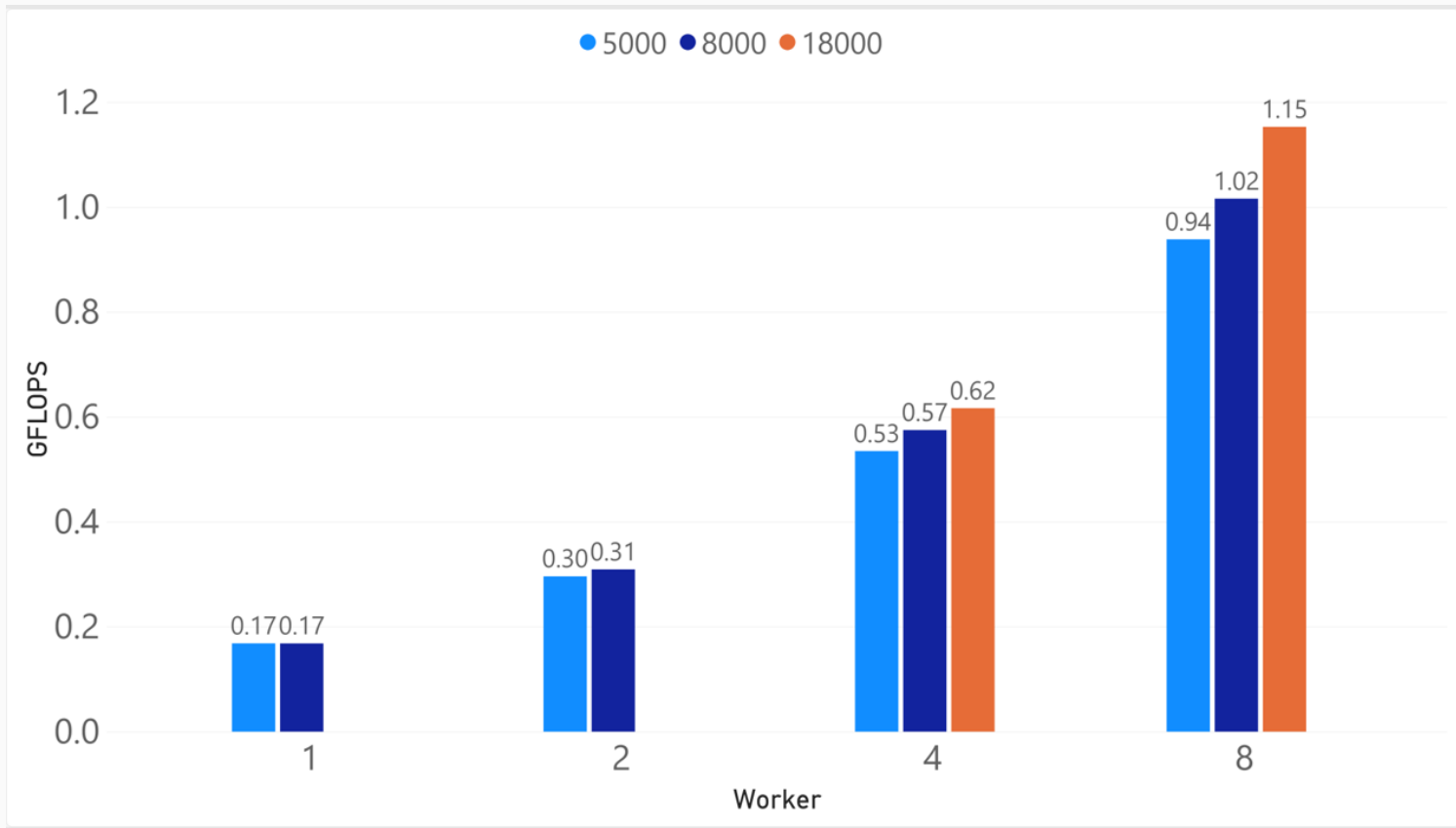


Figure 3:HPL/LINPACK Performance

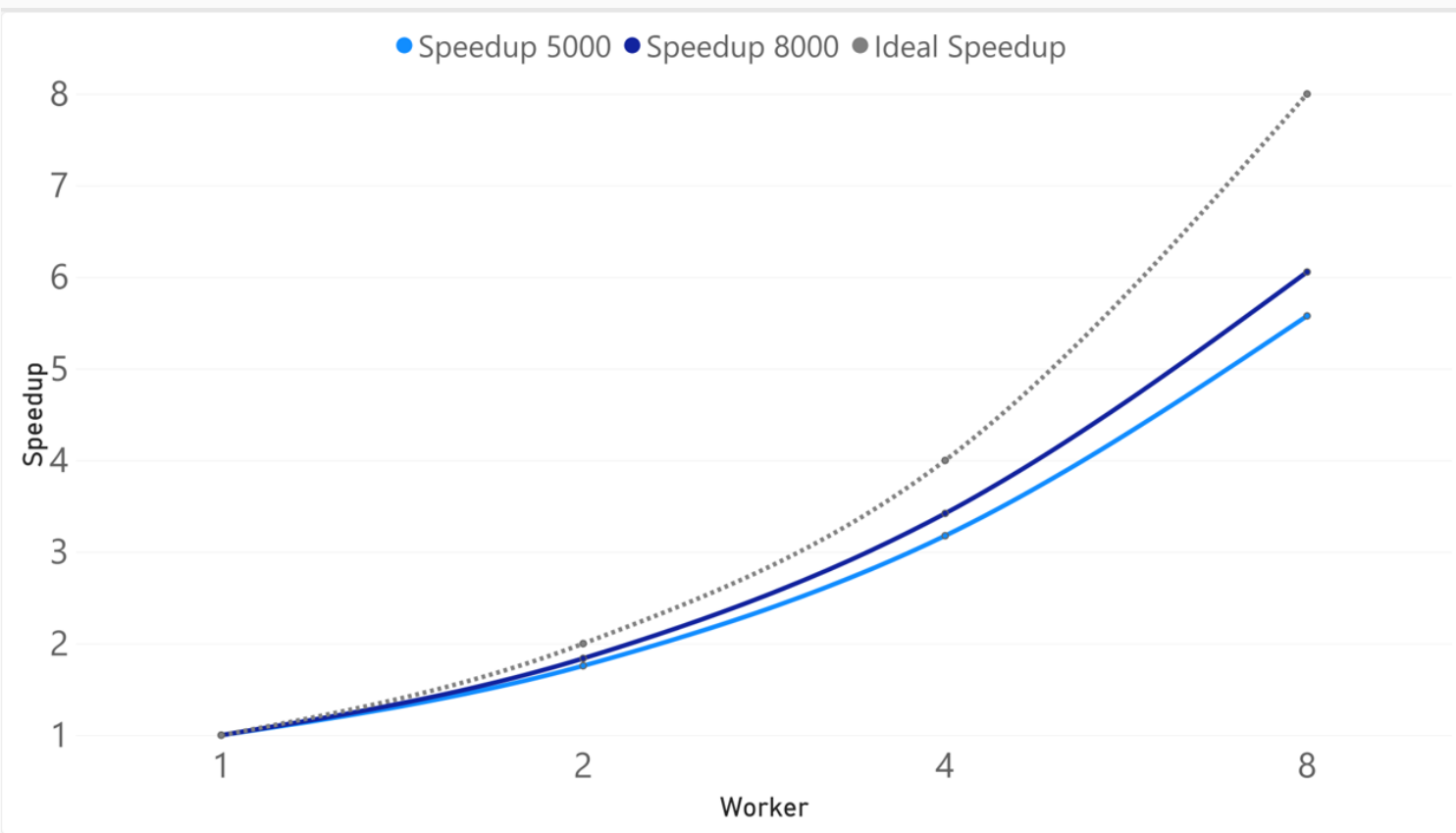


Figure 6:HPL Strong Scaling

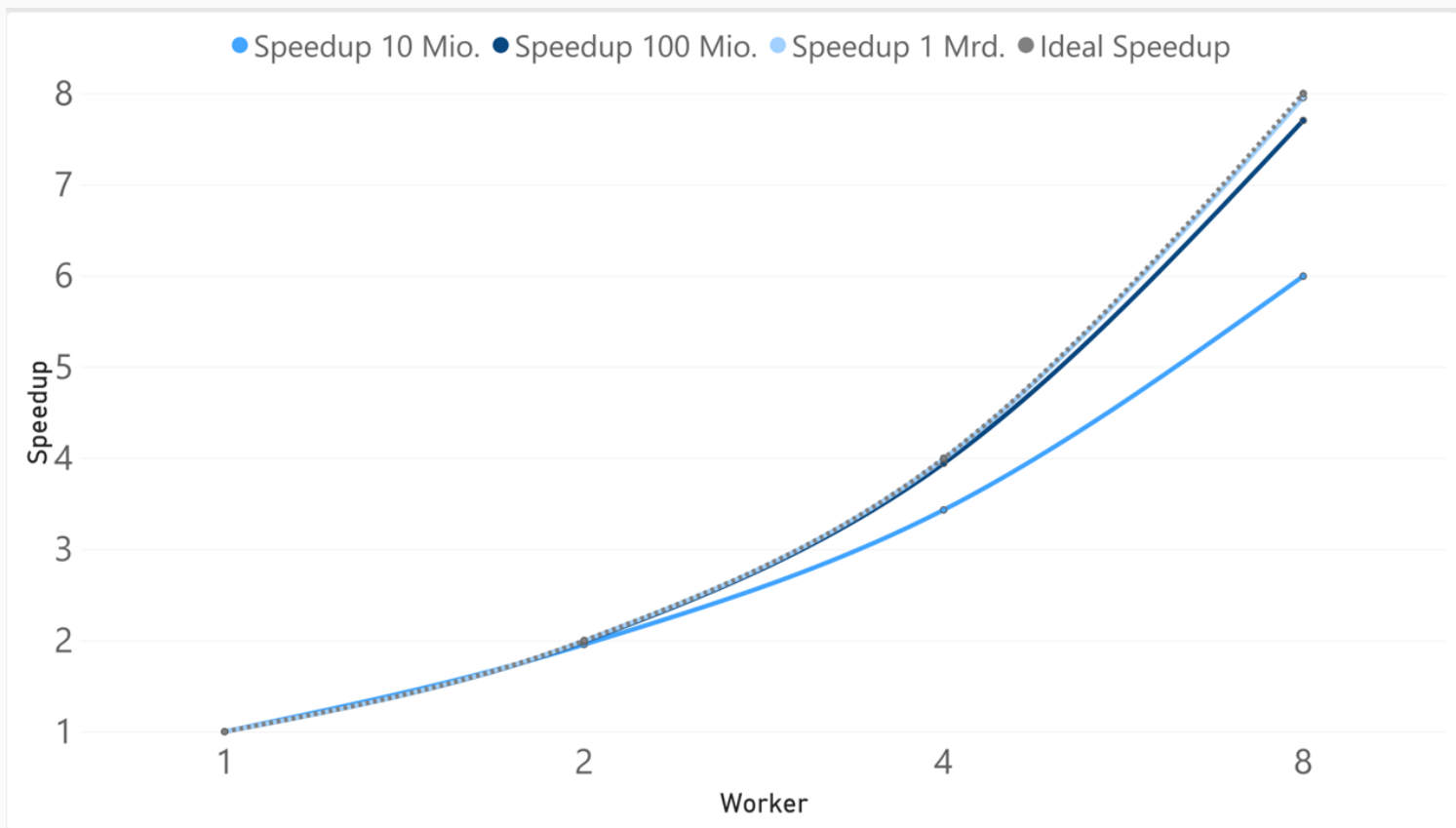


Figure 4:Monte Carlo Strong Scaling



Figure 7:Matrix Multiplication Strong Scaling

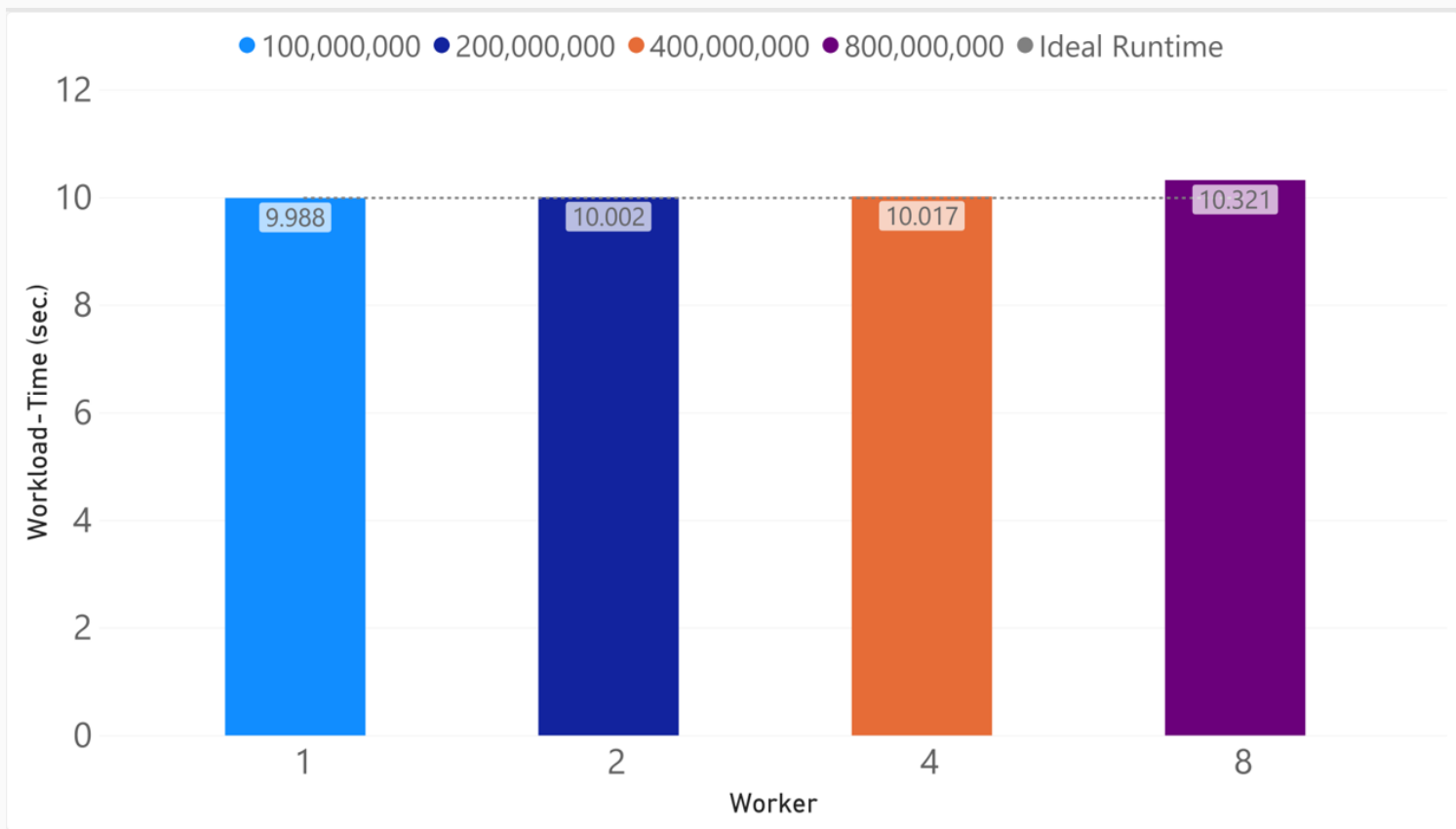


Figure 5:Monte Carlo Scaled Workload

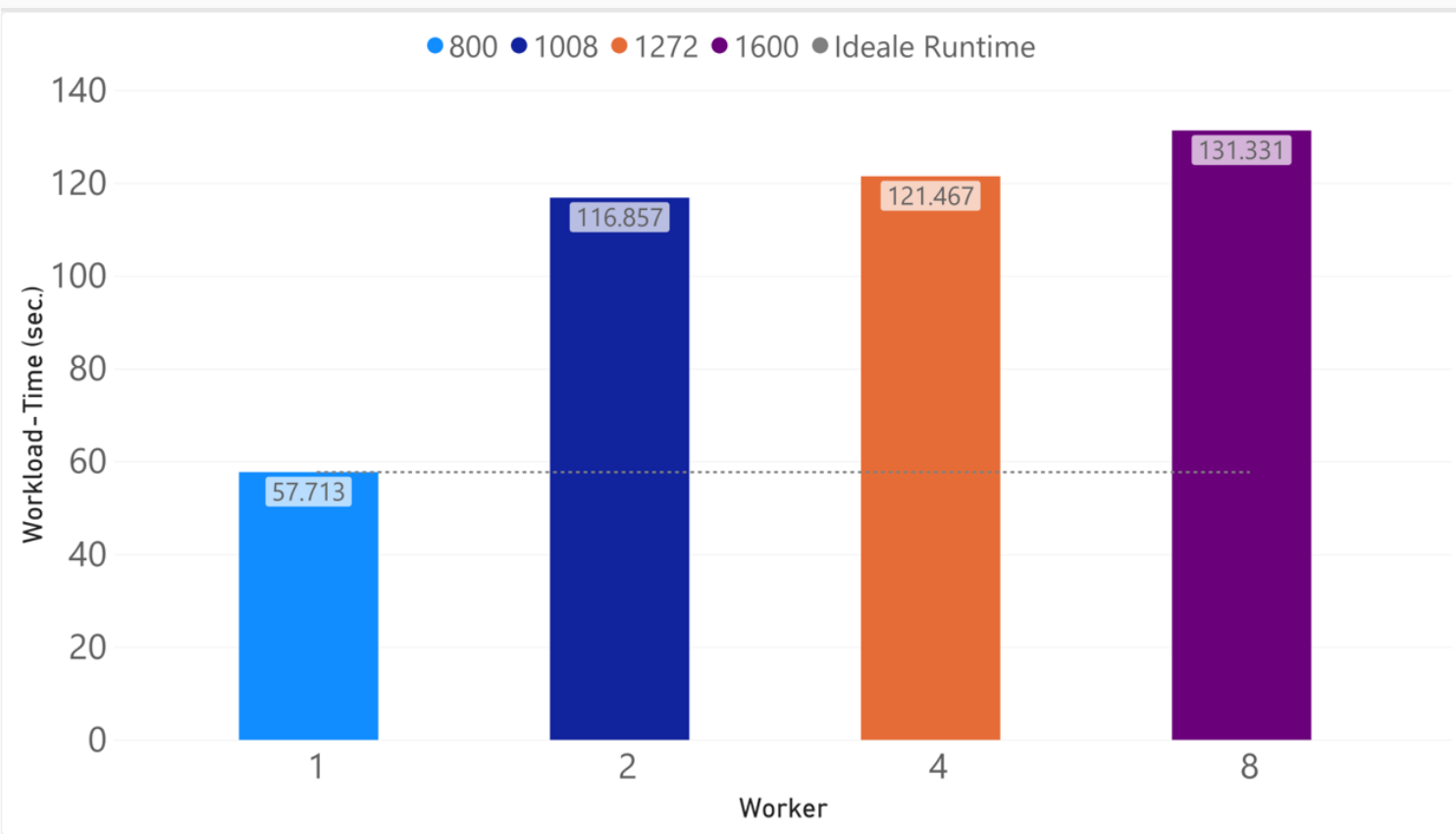


Figure 8:Matrix Multiplication Scaled Workload

Monitoring

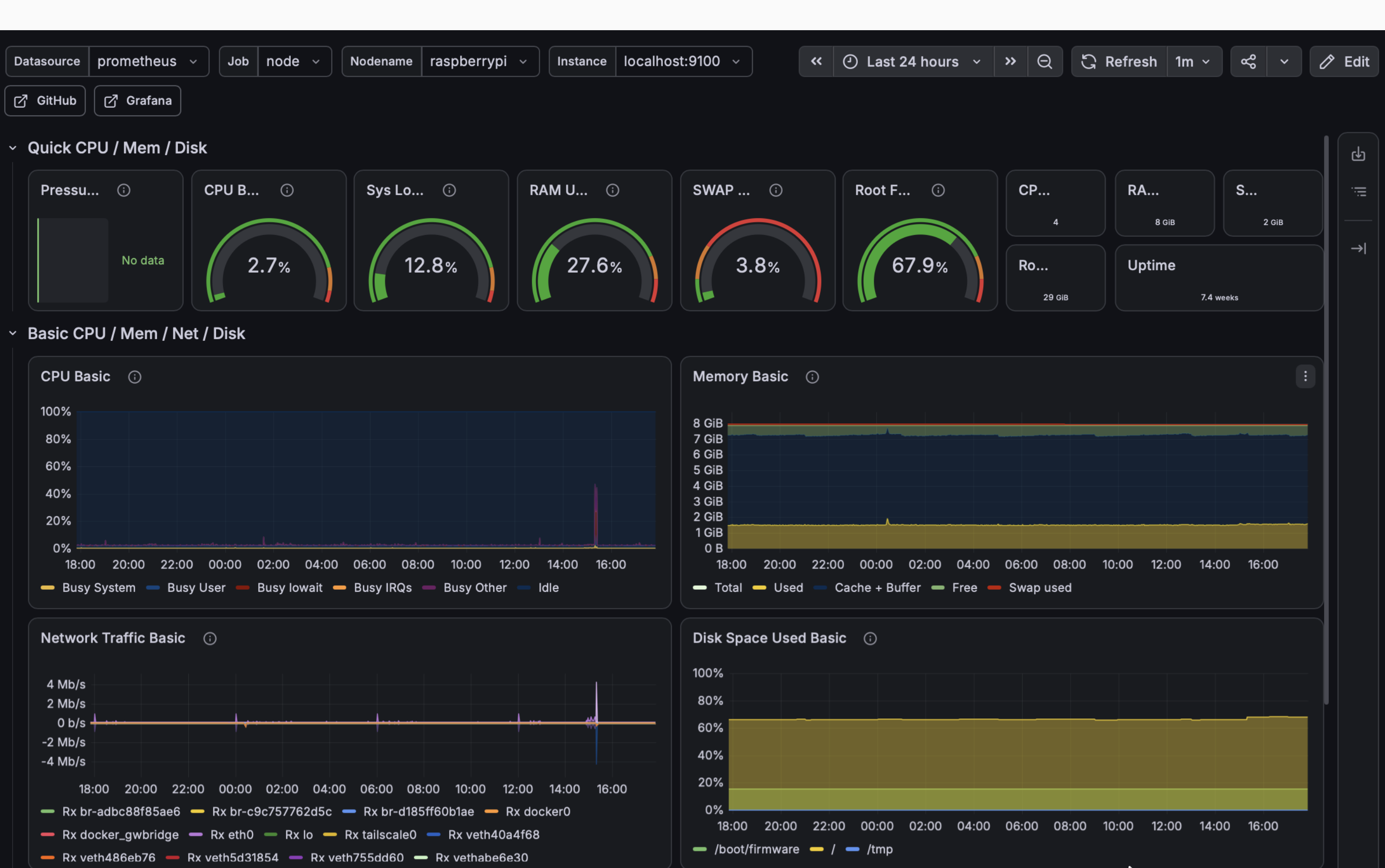


Figure 2:Monitoring

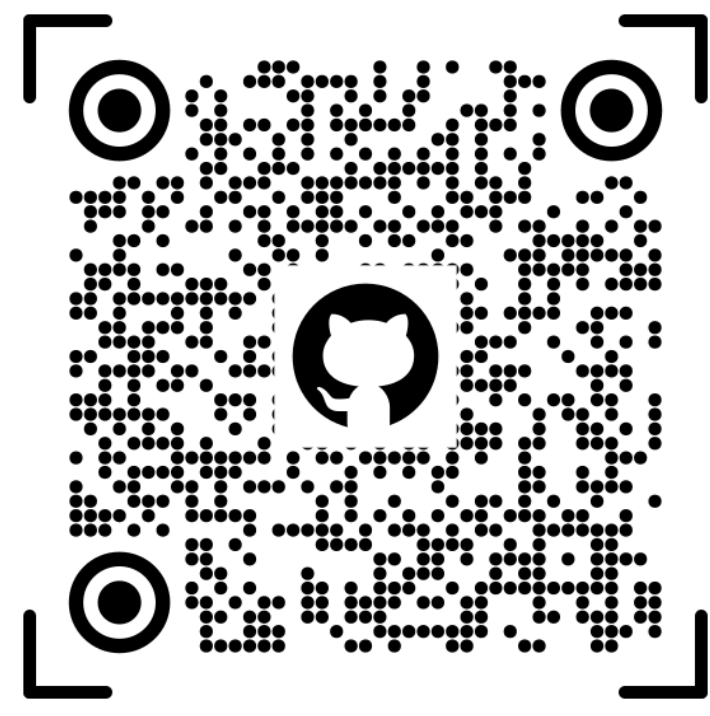
Object Detection & AI Model

AI Model & Architecture: YOLOv11 (Nano) for real-time edge inference.
The project compares two platforms: Raspberry Pi 4 (IMX500 AI Camera) and Raspberry Pi 5 (Hailo-8 AI HAT+)
Threat Detection (Classes): Identification of three specific threats: *Fire*, *Knife*, and *Person*
Training & Data (Roboflow): Custom dataset merged with public datasets, heavily augmented (rotation, brightness, mosaic), and split 70/15/15
Deployment 1 (IMX500): Model exported to `.imx` via Sony MCT for direct, resource-efficient on-sensor inference
Deployment 2 (Hailo-8): Compilation via ONNX into `.hef` format for high-performance hardware acceleration
Alerting: Real-time event notifications sent to the backend and integrated with a custom Telegram Bot

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References



[1] M. Morelle. Cloud computing. <https://github.com/MikeMorelle/MikeMorelle.github.io>, 2026.