UTHM
Universiti Tun Hussein Onn Malaysia

FACULTY OF COMPUTER SCIENCE AND INFORMATION

BIK10303 – Computer Architecture

DESIGN ISSUES IN COMPUTER ARCHITECTURE

Group Members

MD JOWEL

AI250004

AHMED NASHWAN AHMED AL-MASWARY

AI250001

DIPTO HOWLADER

AI250002

ANAS AWSAN ABDULRAZZAQ MUSAED SALLAM

AI250036

UTHM

DESIGN ISSUES IN COMPUTER ARCHITECTURE

Nintendo Switch 2 Heating Problem

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Introduction

The **Nintendo Switch 2, released in 2025,** is a hybrid gaming console that combines handheld portability with docked performance. It features a custom ARM-based NVIDIA CPU, integrated GPU, DDR5 memory, and modular Joy-Con controllers. While these upgrades improve graphics and usability, the device suffers from **overheating in handheld mode,** which impacts comfort, performance stability, and long-term reliability.

Device Technology & Design:

- **CPU:** ARM-based custom NVIDIA processor with multiple cores
- **GPU:** Integrated graphics unit for dynamic rendering
- **Memory:** DDR5 RAM + multi-level cache hierarchy
- **I/O:** Modular Joy-Con controllers, Bluetooth 5.2, Wi-Fi 6, USB-C
- **Hybrid design:** portable handheld mode + docked console for TV gaming

The Problem:

- Overheating reduces user comfort and device reliability
- Performance throttling during intensive gameplay
- Risk of permanent hardware damage

Project Aim:

Analyze the heating issue and propose a conceptual redesign with improved cooling and workload management, demonstrating how Computer Architecture principles solve real-world device challenges.

Architecture Overview

CPU: ARM-based custom NVIDIA processor with multiple cores.

GPU: Integrated graphics unit supporting dynamic rendering and frame scaling.

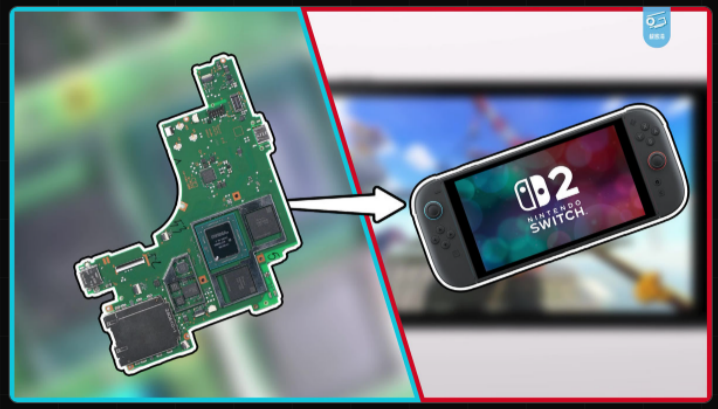
Memory: 8 GB DDR5 RAM + multi-level cache hierarchy (L1, L2, shared L3).

Storage: 64–256 GB internal flash, expandable via microSDXC, NVMe SSD support in docked mode.

I/O Modules:

- Joy-Con controllers
- Bluetooth 5.2
- Wi-Fi 6
- HDMI, USB-C, audio jack

Compact motherboard layout prioritizes portability but restricts airflow.



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Identified Issue: Heating

Symptoms:

- Console too hot to hold
- Fans at max speed
- Games crash during intensive play

Nintendo Warning:

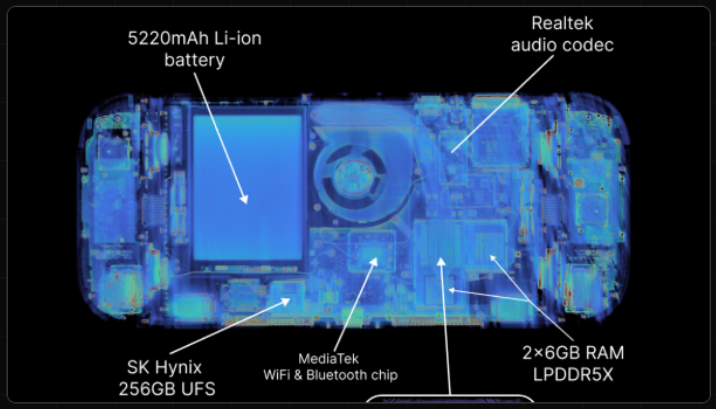
- Avoid use above 35°C
- Safe range: 5°C–35°C

Causes:

- High CPU/GPU workloads for modern AAA titles
- Limited passive cooling in handheld mode
- Restricted airflow due to compact design

Impact:

Usability discomfort, performance throttling, risk of permanent damage.



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Proposed Enhanced Architecture

Cooling system: vapor chamber + liquid microchannels for efficient heat dissipation.

Workload management: dynamic CPU/GPU scheduling to reduce thermal spikes.

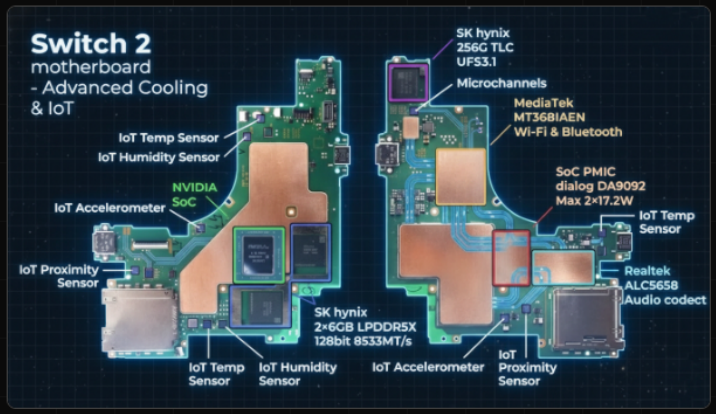
Adaptive fan control: larger vents, smart airflow regulation based on sensor data.

Heat-spreading materials: graphene layers, liquid metal TIM for better conductivity.

IoT Integration:

- Temperature sensors for predictive cooling
- NFC alerts when thermal thresholds are exceeded

Result: stable handheld performance, reduced overheating, improved reliability.



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Commercialization & Performance vs Cost

Trade-offs:

- **Higher cost:** Vapor chamber cooling and IoT sensors add extra materials and complexity, raising production costs.
- **Improved reliability:** Better cooling keeps CPU/GPU stable, prevents overheating, and extends hardware lifespan.
- **Better user satisfaction:** Stable handheld performance reduces heat discomfort and fan noise, making gameplay smoother and more enjoyable.

Commercialization angle:

- "Switch 2 Pro" appeals to gamers who want handheld power without overheating
- Balanced design ensures performance gains justify added cost

Feature	Switch 1	Switch 2	Switch 2 Pro
CPU/GPU	Tegra X1	Custom NVIDIA	**Optimized NVIDIA + scheduling**
Memory	DDR4	DDR5	**DDR5X + cache tuning**
Cooling	Basic fan	Limited vents	**Vapor chamber + microchannels + adaptive fan**
Usability	Stable but low performance	High performance but overheating	**Stable + high performance**
Cost	Low	Moderate	**Higher but balanced**

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Conclusion

Heating is a real architectural issue in the Nintendo Switch 2.

Proposed enhanced design solves overheating with advanced cooling and smart workload management.

The "Switch 2 Pro" concept offers:

- Better user experience
- Improved reliability
- Commercial viability through balanced performance vs cost

Demonstrates how Computer Architecture redesign can solve real-world device problems.

THANK YOU

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