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Charging Speed vs. Daily Performance: A Comparative Analysis of Battery Duration in Smartphones Under Different Charging Regimens

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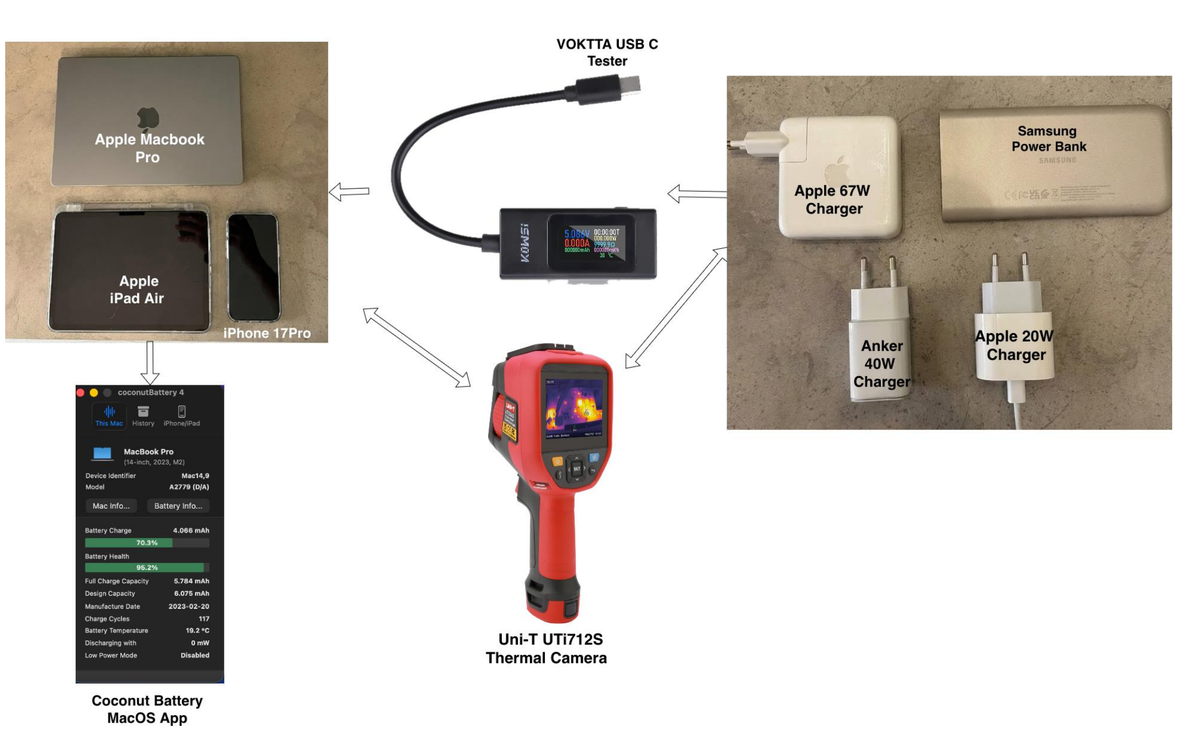
INTRODUCTION & AIM

- Smart devices have become an integral part of the infrastructure in the modern daily lives workflow.
- Lithium-ion batteries are currently the industry standard for electronics because they offer a better energy density and are more robust than any other type of battery.
- To keep device downtime to a minimum, fast-charging protocols are becoming more commonplace with tremendous thermal management challenges.
- The Research Gap: Little clarity as to how fast charging impacts immediate daily discharge duration versus long-term capacity fading.
- Comparative Scope: The research considers performance on a specific scope of comparison, OEM vs 3rd-party hardware, Fast vs Normal mode of charging, etc.
- **Aim**: Explore the effect of fast charging on battery life cycle & useful lifespan

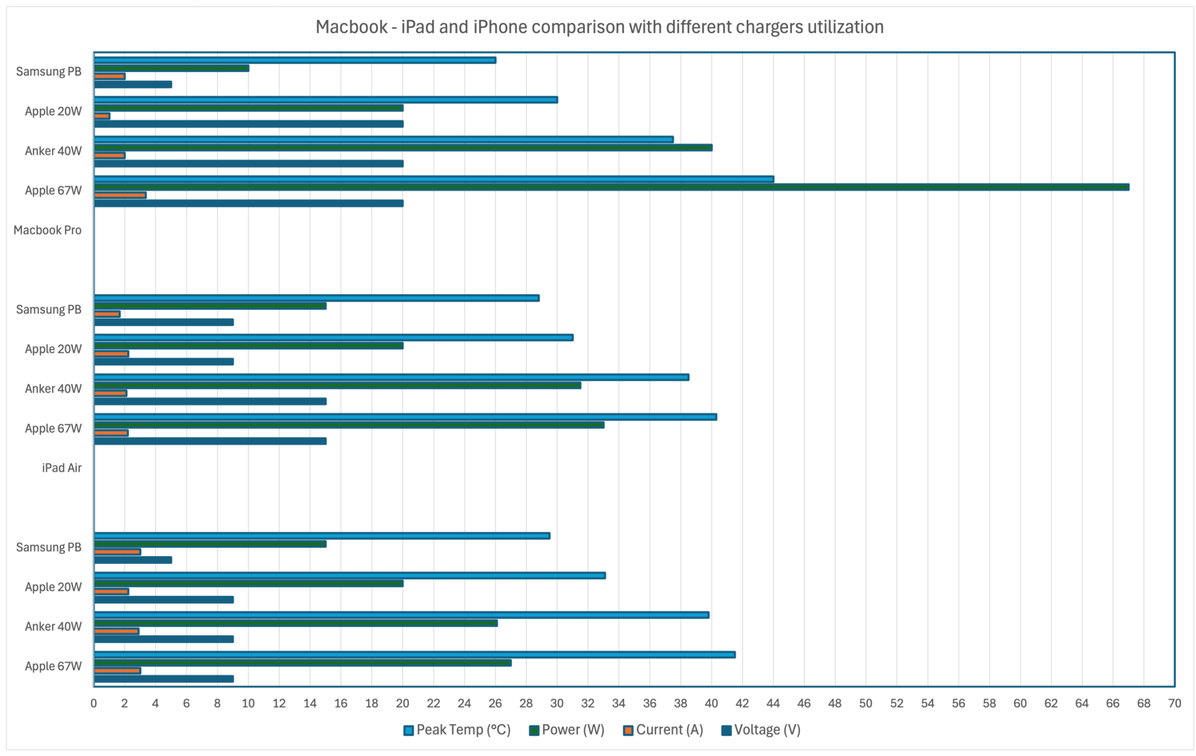
METHOD

- **Testbed**: Multi-device –iPhone, iPad and MacBook Pro, are utilized to continuously log values voltage, current, temperature, and State of Charge (SoC).
- **Software**: Coconut battery software is used for logging, which can also calculate each battery State of Health
- **Monitoring**: For real time monitoring, a USB type C adapter by Voktta is employed along with a thermal camera by Uni-T (UTi712S) to check core temperature.
- **Test**: Deployed on an apartment in Athens (Peristeri); monitored continuously for 10 days from September 26 to October 6 (25°C Ambient temperature).
- The layout of the experiment is presented below:

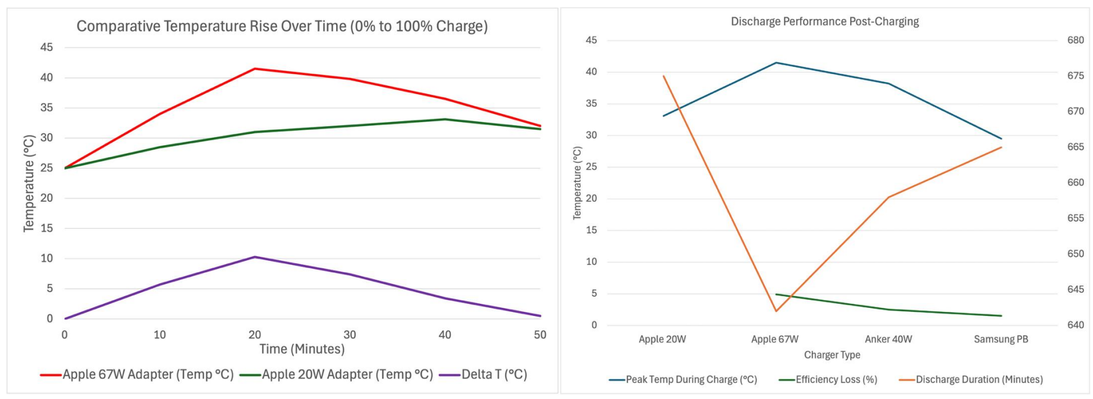


RESULTS & DISCUSSION

- **Voltage Negotiation(USB-PD):** data shows that while the device, and not the charger, controls the voltage request.
- However, the higher available amperage (3.0A) brings the battery chemistry to the thermal limit (41.5 ° C).
- **Thermal Throttling**: For the iPhone and iPad this difference in temperature between the 20W and 67W chargers is significant (~8°C - 10°C).
- **Hence** this pattern forces cells out of their optimum thermal zone (20-35°C) which reduces the immediate discharge cycle.



- After charging to 100%, the device runs a continuous 4K vid loop until shutdown.
- Comparison during charging-Discharging is shown below:



CONCLUSION

- The most important factor causing thermal stress is the charging and discharging rates
- Data shows users should go with ordinary standard low current charging to ensure battery lifespan
- Raised internal temperatures cause increased internal resistance which results in a decreased discharge efficiency

FUTURE WORK / REFERENCES

- Fast charging also speeds up long term degradation mechanisms, e.g. Solid Electrolyte Interphase (SEI) layer thickening, requiring further longitudinal study.

Teodorescu, R.; Sui, X.; Vilsen, S.B.; Bharadwaj, P.; Kulkarni, A.; Stroe, D.-I. Smart Battery Technology for Lifetime Improvement. Batteries 2022, 8, 169. https://doi.org/10.3390/batteries8100169