

Fire in Your Hands: Understanding Thermal Behavior of Smartphones

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Apple investigating iPhone 6 explosion in California

By Malcolm Owen

Sunday, July 14, 2019, 05:52 am PT (08:52 am ET)

Apple is investigating why an iPhone 6 owned by an 11-year-old girl in California 'exploded' while being used to watch YouTube videos, an incident that luckily avoided any serious injury to the child or property damage.



Man claims Samsung Galaxy S10 caught fire when charging, sues for one yuan

- Xinjiang resident says smoke and flames started coming out of US\$875 device two days after he bought it online
- Court will rule on claim for symbolic damages, a full explanation and apology from the manufacturers



Zhuang Pinghui

Published: 8:00pm, 3 Jul, 2019



FIRE FEARS Another Samsung owner says phone EXPLODED – almost giving her 'severe burns'

It's the second shocking claim of an exploding Samsung phone this month, rekindling fears over the company's safety record

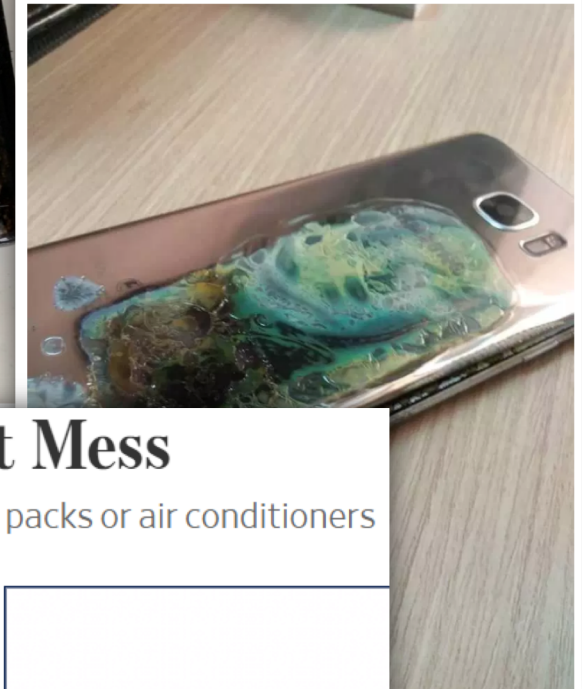
PICTURED

By Sean Keach, Digital Technology and Science Editor
20 Sep 2018, 11:44 | Updated: 21 Sep 2018, 17:04

5 COMMENTS

A SAMSUNG customer claims his phone exploded, setting fire to towels and almost giving her "severe burns".

The disgruntled owner says she's "done with Samsung" after the incident, which joins a catalogue of dozens of similar claims made about Samsung handsets.

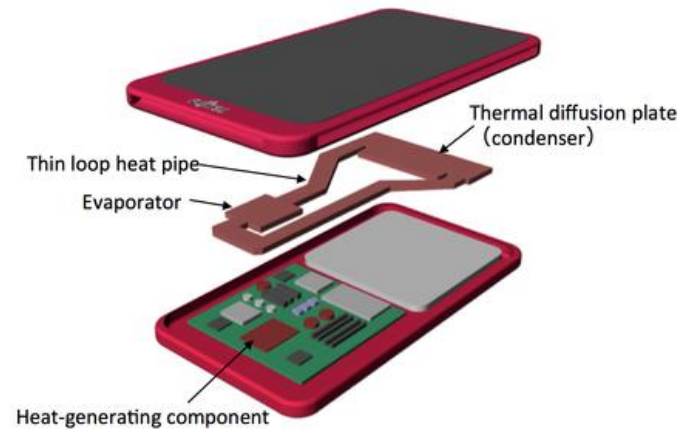


We Tested 5G Across America. It's Crazy Fast—and a Hot Mess

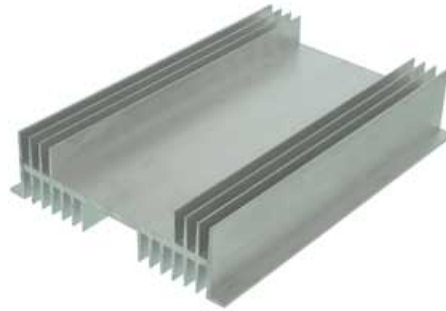
In tests, the 5G often switched off due to summer heat, leaving our columnist to cool the devices with ice packs or air conditioners

5G Testing Results: Pack Your Tent and Cooler

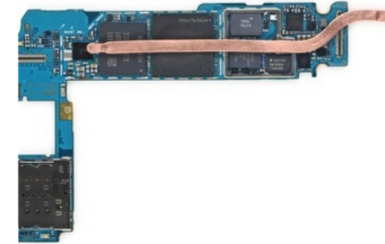
Traditional Cooling techniques



Heat pipe



Heat sink



Thermal-interface materials

Traditional Cooling techniques



Air Cooling



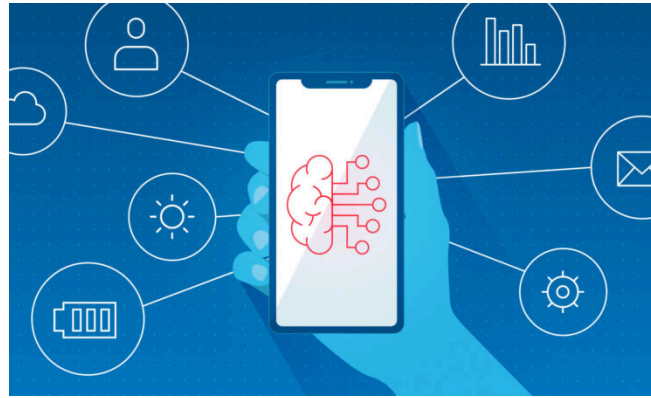
Water Cooling

➔ Not applicable to smartphones!

Overheating problem in Smartphones



AR applications



Machine learning applications



Games



Close contact with smartphone surface



Users start to feel discomfort and pain from **45°C**

When and how much heat smartphones generate in practical scenarios?








Surface temperature Analysis

Target device:

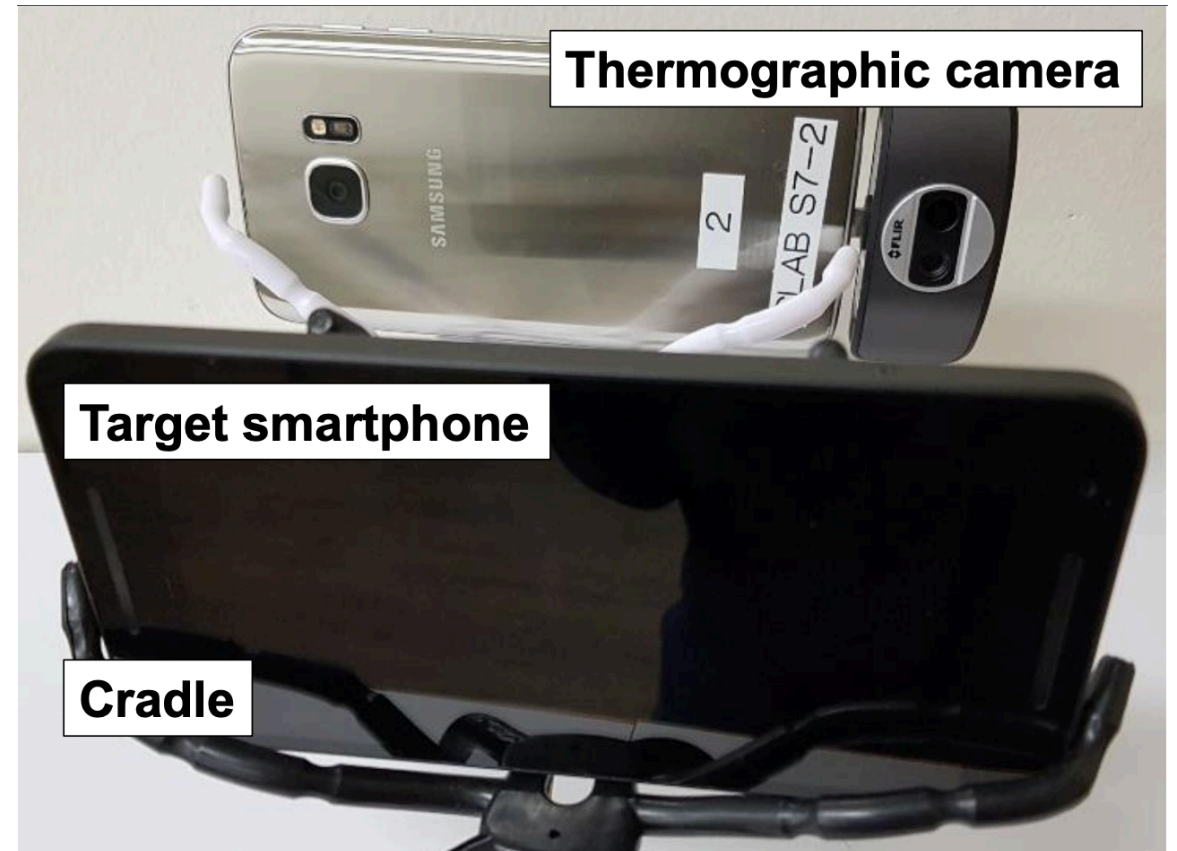
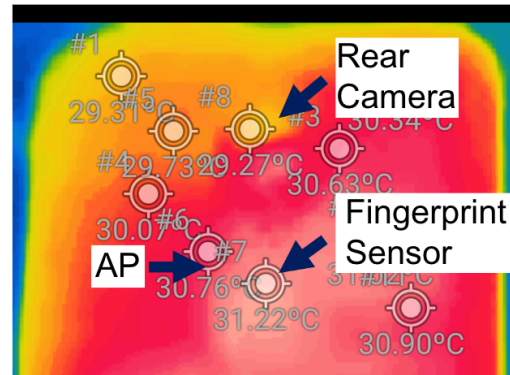
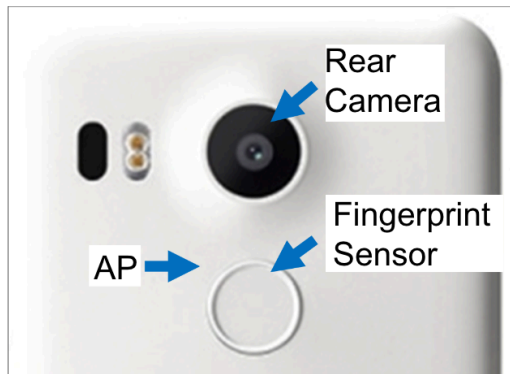


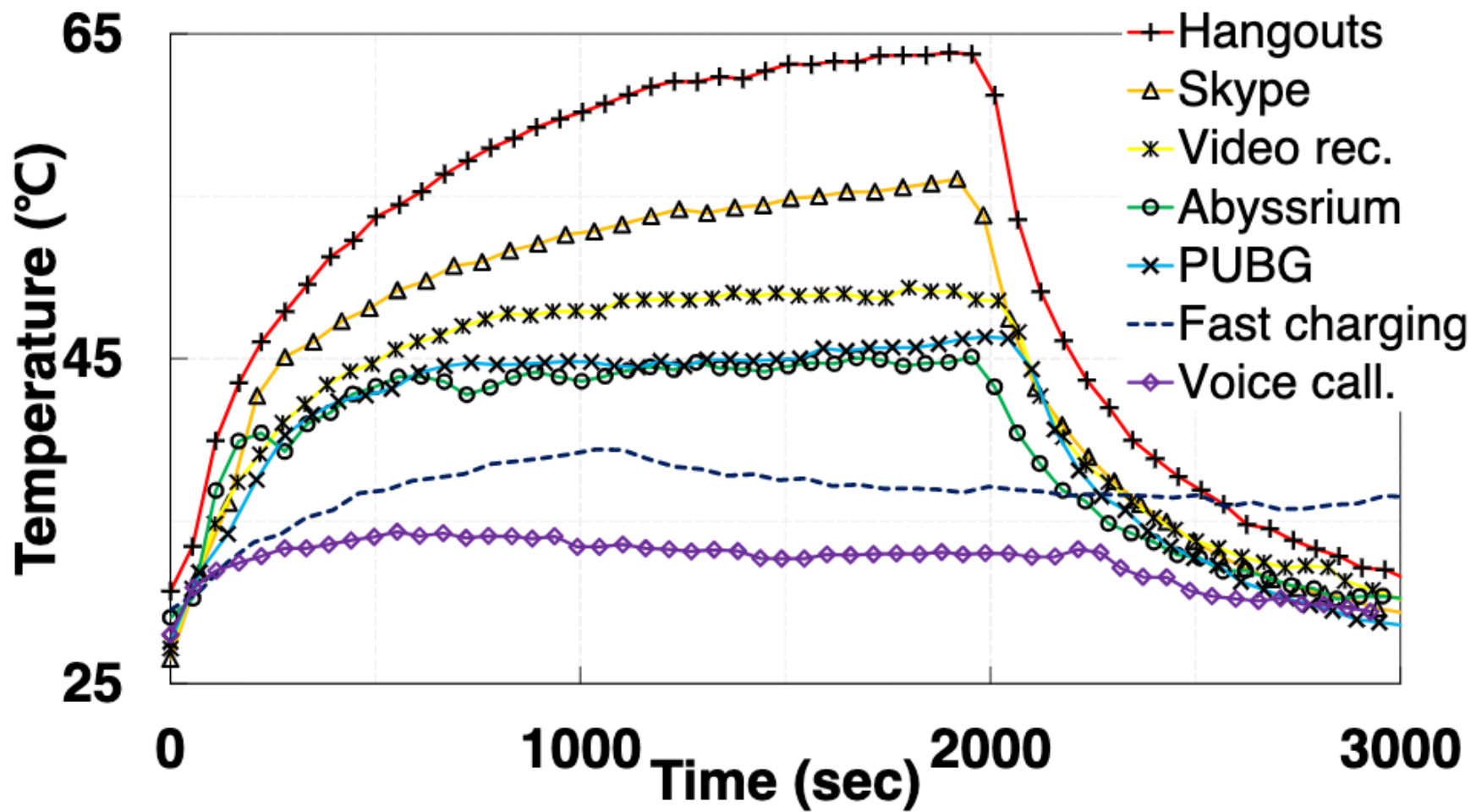
Nexus 5X

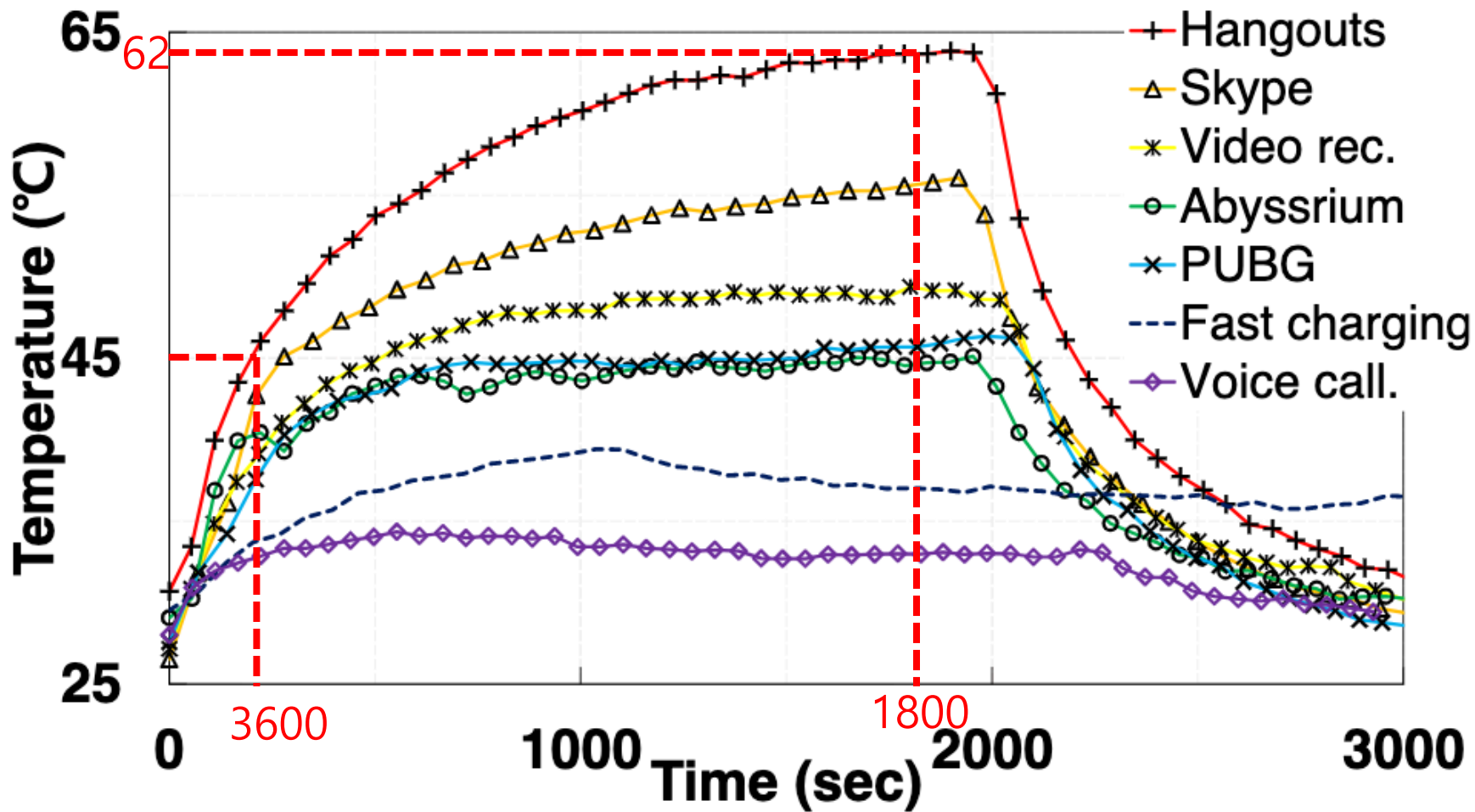
Applications:

- Video chat  
- Video recording 
- Game  
- Voice call 
- Charging 

Surface temperature Analysis



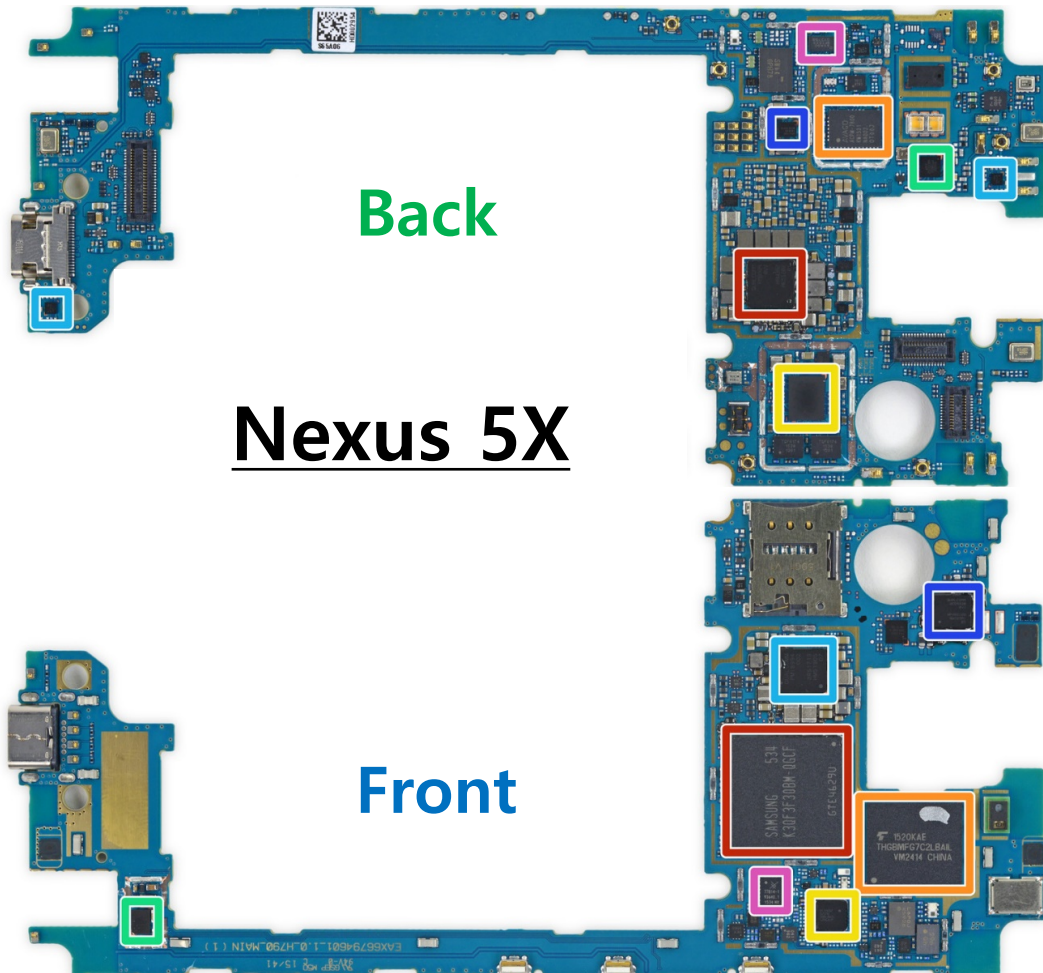




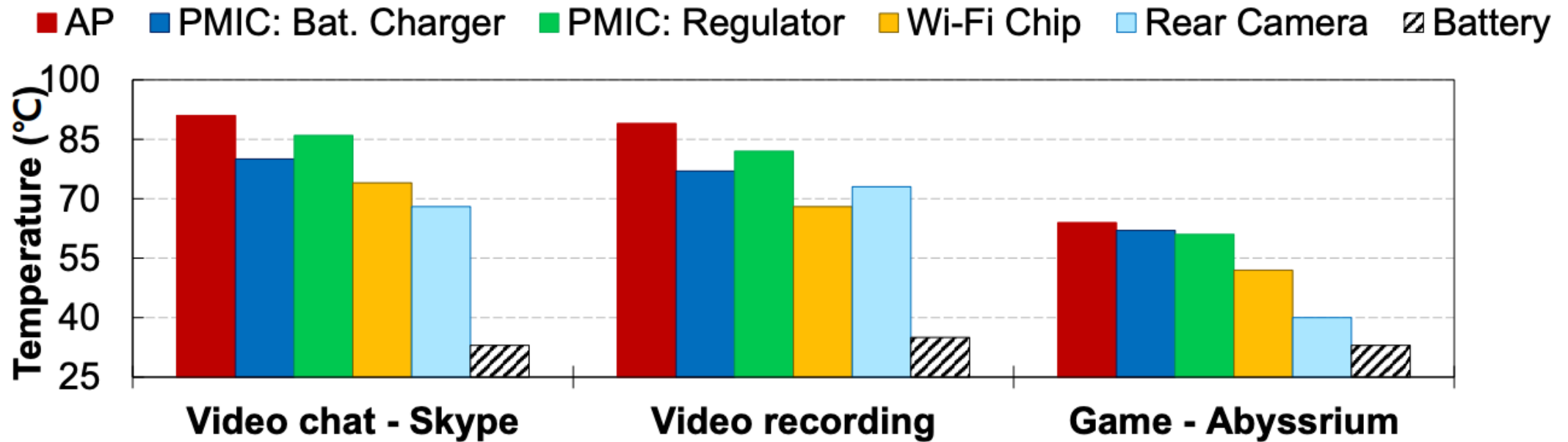
Takes only 6 minutes to reach 45°C

Reaches 62°C in 30 minutes!

Component-specific Analysis



Component-specific Analysis



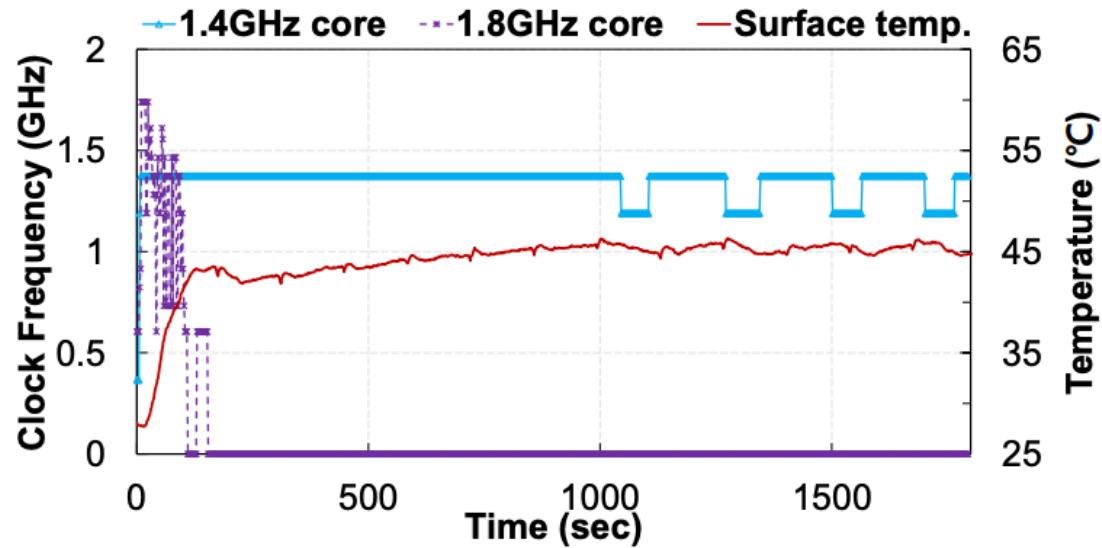
Steady-state temperature of each component while running each application

69% CPU utilization

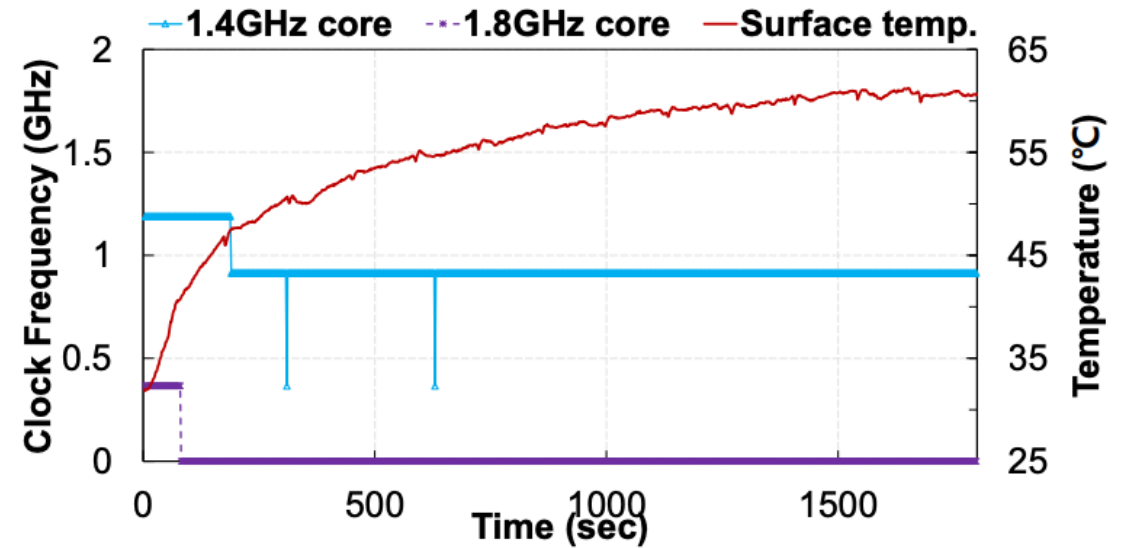
30% CPU utilization

Multimedia codec built into the AP generates significant heat

CPU-utilization, in itself, is not responsible for overheating



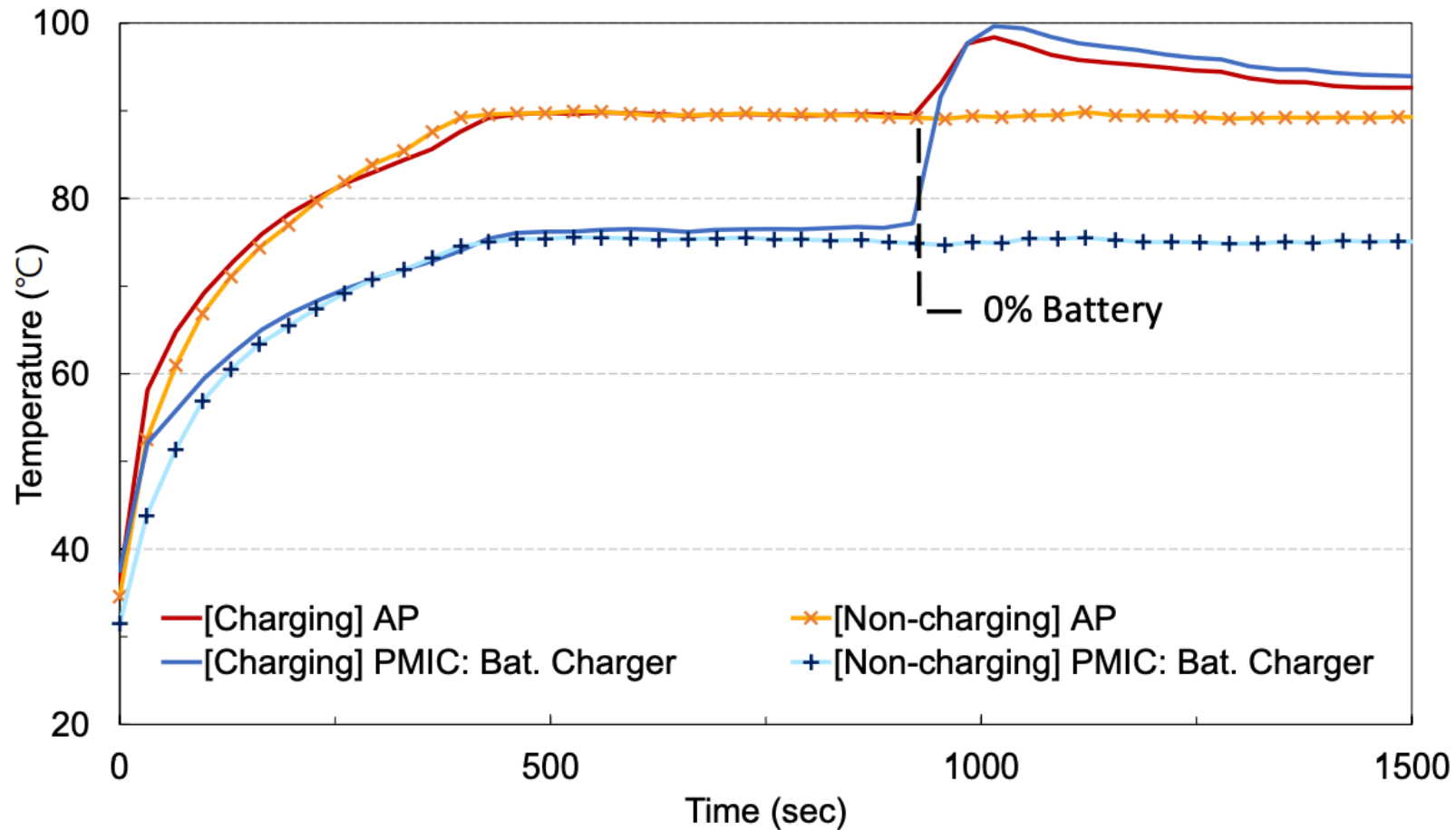
(a) CPU-intensive workload.



(b) Video rec. workload.

Multimedia codec does not have thermal management capability!

Video recording while charging



AP, PMIC reached 100°C as soon as battery level dropped to 0%
Due to PMIC Charging algorithm

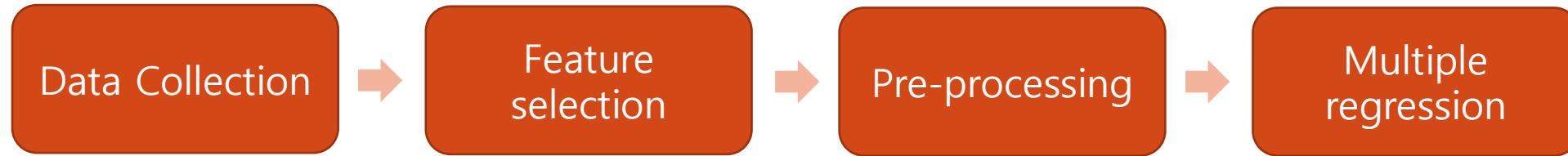
How can we solve this problem?

Predicting surface temperature

*Predict surface temperature using **Android system statistics***

- 17 CPU statistics
 - (e.g. CPU%, User%, System%,)
- 2 Network sensors
 - Tx data rate(netTx), Rx data rate (netRx)
- 2 On-device Sensors
 - CPU temp
 - Battery temp

Predicting surface temperature

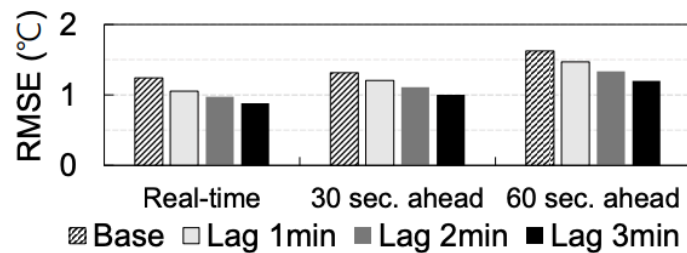


6 apps
→ Obtain 40 instances
(1200 minutes)

Correlation-based
feature selection (CFS)

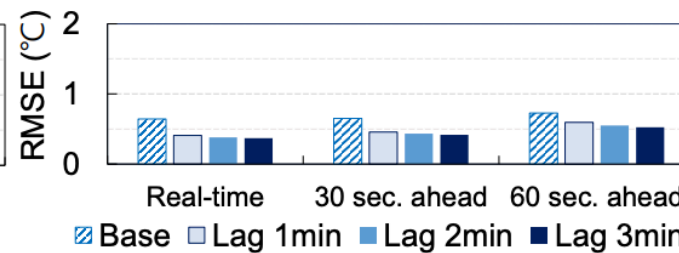
Time lagging

$$y_t = \vec{\alpha}^T X_t + \vec{\beta}^T X_{t-L} + \epsilon_t$$



(a) Nexus 5X.

RMSE: 1.24°C



(b) Galaxy S7.

RMSE: 0.64°C

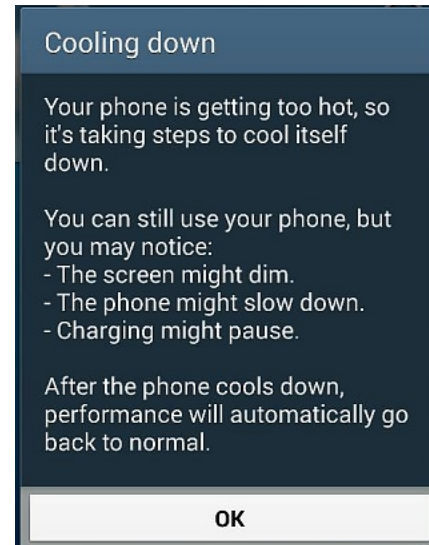
Implications

User experience



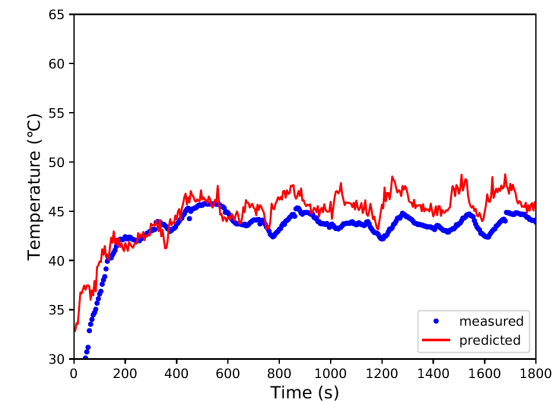
Should consider overheating problems raised from newly introduced apps (VR/AR, mobile deep learning)

OS design



Requires user-imposed regulation for thermal management

Developer support



Developers should consider user interaction as well as user reaction patterns