Making gadgets really cool

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Response to Thermal

- **User/Device safety range:**
  - Extreme die temp > 100 °C
  - SoC, charger IC, PMIC etc.
- User comfort range (say > 35°C)
  - Action: easy, shutdown!
  - Generally hardware assisted
- User comfort range (say > 35°C)
  - Importantly for user comfort/perception
  - Achieved by complex throttle actions
  - Defers critical actions
Throttle: negative feedback loop

- Thermal zones:
  - Battery, CPU, GPU...

- Throttle targets:
  - CPU-freq
  - GPU-freq
  - Display brightness
  - Charge current...

- TM policy

```
thermal_sys.c
thermal_zone_device_register()
thermal_cooling_device_register()
thermal_zone_bind_cooling_device()
```
Skin zone temperature

User perception:
- Broad range, say > 40°C
- Multiple touch points
- Including display side ear piece
- Net effect of different components on Skin
  - Virtual skin sensor needed.
Tskin virtual sensor

\[ t_{skin} = f(t) \]

Where \( f() \) is,

- Evaluated for given FF
- Prefer a simple formula
- Which gives least errors in operating temp. range
- Details beyond scope, but math is obvious.
Tskin virtual sensor…

- Plug into feedback loop
- Calculate $f(t)$, apply throttle policy as applicable.
- For User space solution: via config file
- kernel space solution: via platform driver that knows the constituent sensors.
TM Policy

- Mapping zone/sensor <-> cdev
  \( m:n \text{ where } (m \subset M) \text{ to } (n \subset N) \)
  - Userspace policy
  - Kernel based policy
- Apply sensor weights by means of trip points
- Apply proportions by exposing correct step from cdev
- No golden rule*. Evaluate for given Form factor.

*But a caution applies...
Policy considerations

- Caution: beware of the knob [config file/trip points]
- more than one scale underneath the needle
- Power-perf-thermal scale alignment
- Applies system wide as well as per component
- Example: Characterize these over Component bound benchmark.
Thank you

Ack
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