

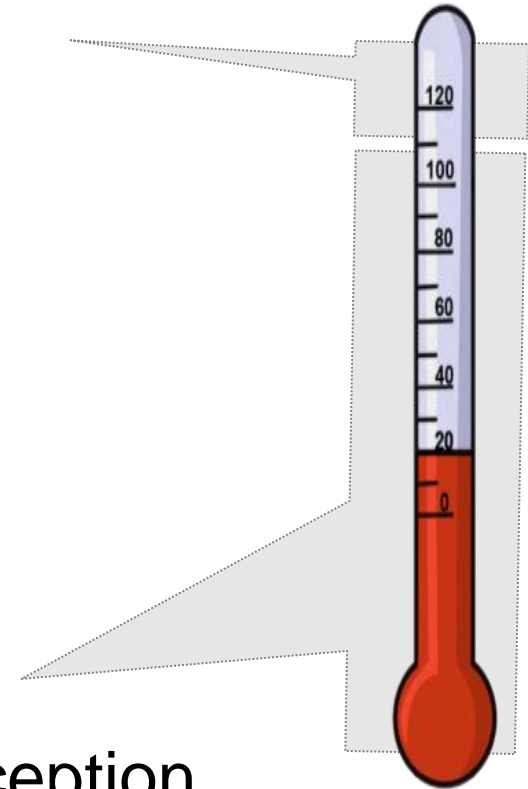
Making gadgets really cool

Noor ul Mubeen
Intel Corporation



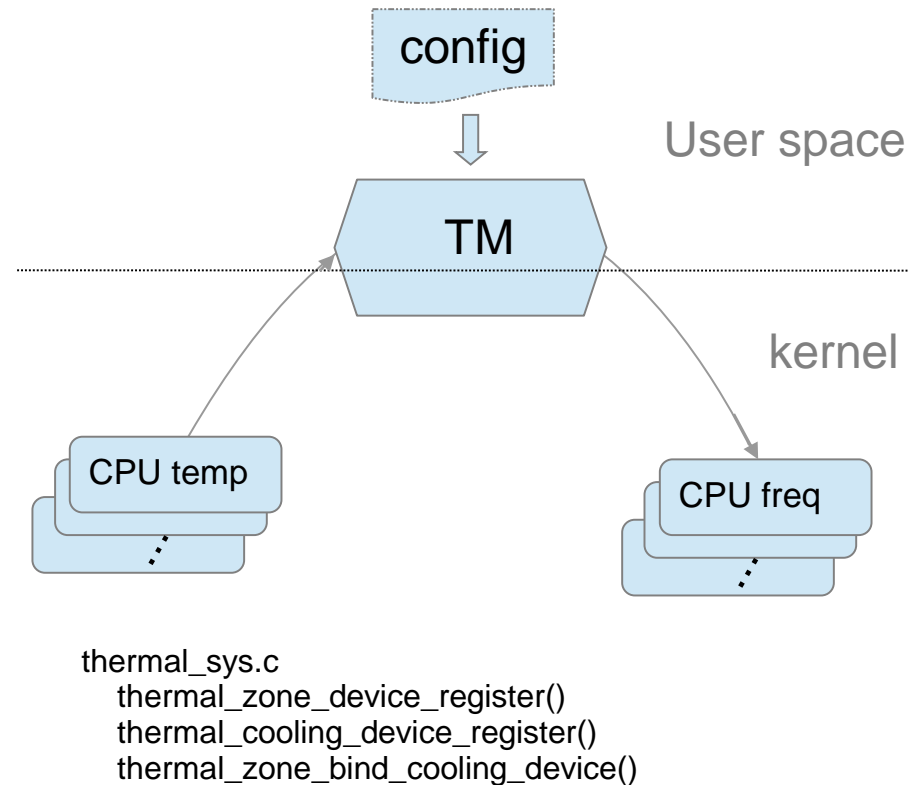
Response to Thermal

- User/Device safety range:
 - Extreme die temp $> 100\text{ }^{\circ}\text{C}$
 - SoC, charger IC, PMIC etc.
 - User comfort range (say $> 35\text{ }^{\circ}\text{C}$)
 - Action: easy, shutdown!
 - Generally hardware assisted
- User comfort range (say $> 35\text{ }^{\circ}\text{C}$)
 - Importantly for user comfort/perception
 - Achieved by complex throttle actions
 - Defers critical actions



Throttle: negative feedback loop

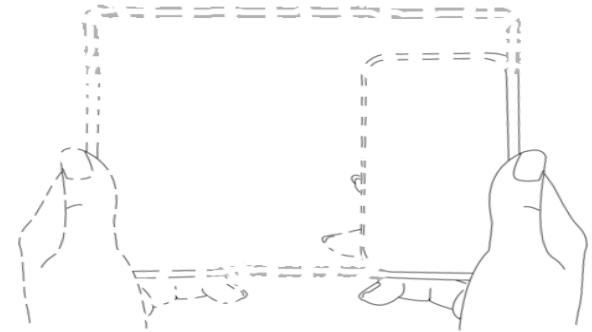
- Thermal zones:
 - Battery, CPU, GPU...
- Throttle targets:
 - CPU-freq
 - GPU-freq
 - Display brightness
 - Charge current...
- TM policy



Skin zone temperature

User perception:

- Broad range, say $> 40^{\circ}\text{C}$
- multiple touch points
- Including display side ear piece
- Net effect of different components on Skin
 - virtual skin sensor needed.

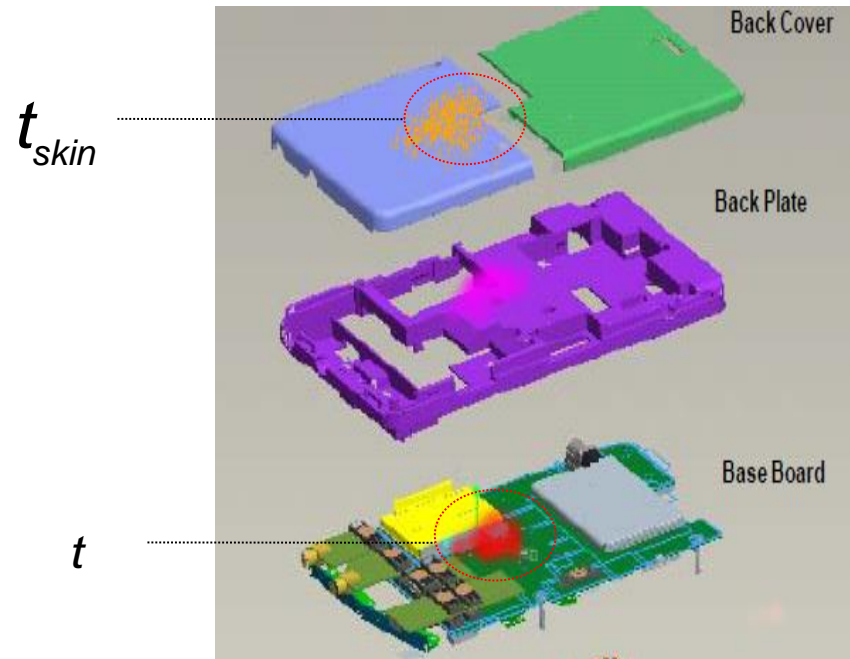


Tskin virtual sensor

$$t_{skin} = f(t)$$

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.

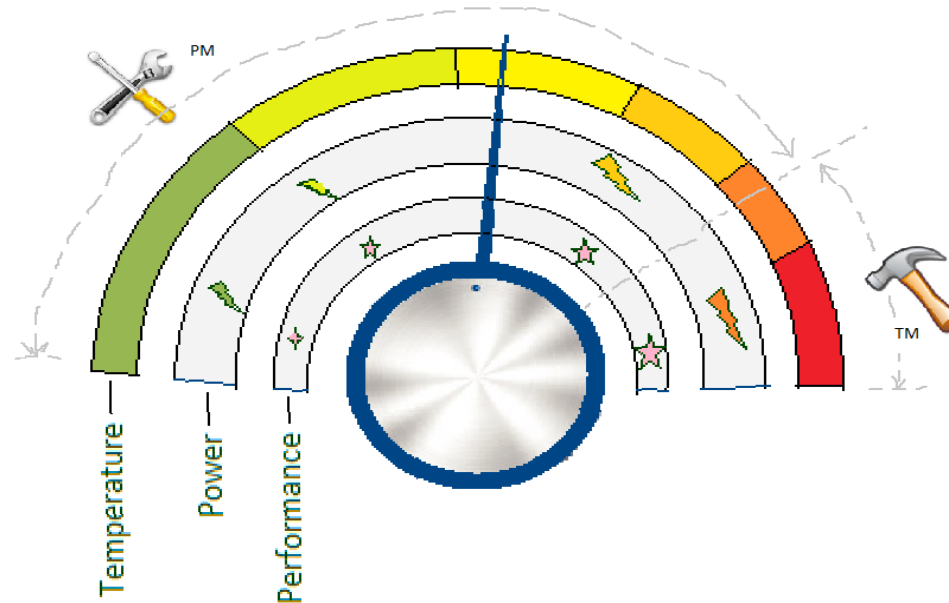
TM Policy



- Mapping zone/sensor \leftrightarrow cdev
m:n where $(m \subset M)$ 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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