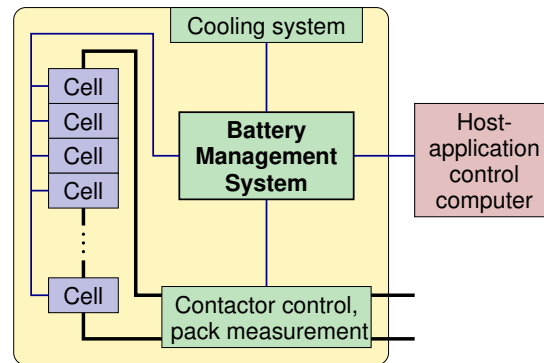## BMS requirement 5: Diagnostics

- So far, we have looked at BMS requirements 1 through 4
- We now consider final requirement 5, *diagnostics*
  - Abuse detection, state-of-health (SOH) estimation, state-of-life (SOL) estimation

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External abuse detection

- BMS often is not in control of battery-pack destiny
- Provides guidance to host application, which host might ignore
- BMS must detect and log external abuse: violation of voltage, current, power, temperature limits

- Log for warranty and post-mortem diagnostics

Internal failure detection

- BMS must detect and log
  - Voltage-, current-, temperature-sensor failures
  - Failures of balancing system
  - Contactor failure
  - Fan or pump failures, loss of coolant
  - Loss of communications, garbled or missing messages from host

State-of-health (SOH)

- BMS must report a battery state-of-health (SOH) estimate
- Not precisely defined; generally, quantifies cell aging to date
- Two measurable indicators change as cell ages naturally
  - Capacity decreases 20 % to 30 %: (capacity fade)
  - Resistance increases 50 % to 100 %: (power fade)
- Estimating R_k and Q_k as the pack operates will give indicators of life. We study this in course 4
- Can also define state-of-life (SOL), which tries to predict how much life remains as a percentage or calendar time
  - Issue: Future rate of cell abuse and aging may differ from past

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Summary

- Final BMS requirement we look at is diagnostics
- Need to be able to detect and log external failures that impact battery
- Need to be able to detect and log internal failures that impact battery
- Need to be able to monitor SOH due to normal degradation processes
- May need to predict SOL as well

Credits

Credits for photos in this lesson

- Puffy iPhone battery cell on slide 2: By Mpt-matthew (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], cropped from https://en.wikipedia.org/wiki/File:Expanded_lithium-ion_polymer_battery_from_an_Apple_iPhone_3GS.jpg
- Failed capacitors on slide 3: By Fromthehill [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Nichicon_2200uF_6.3V_swollen_leaking_capacitors_Compaq_year_2001_motherboard.jpg (cropped)
- "Dead" cell on slide 4: Pixabay license (https://pixabay.com/en/service/license/), https://pixabay.com/en/dead-battery-leak-leakage-charge-1623377/