Reliable Flash-Backed Cache Using SuperCaps

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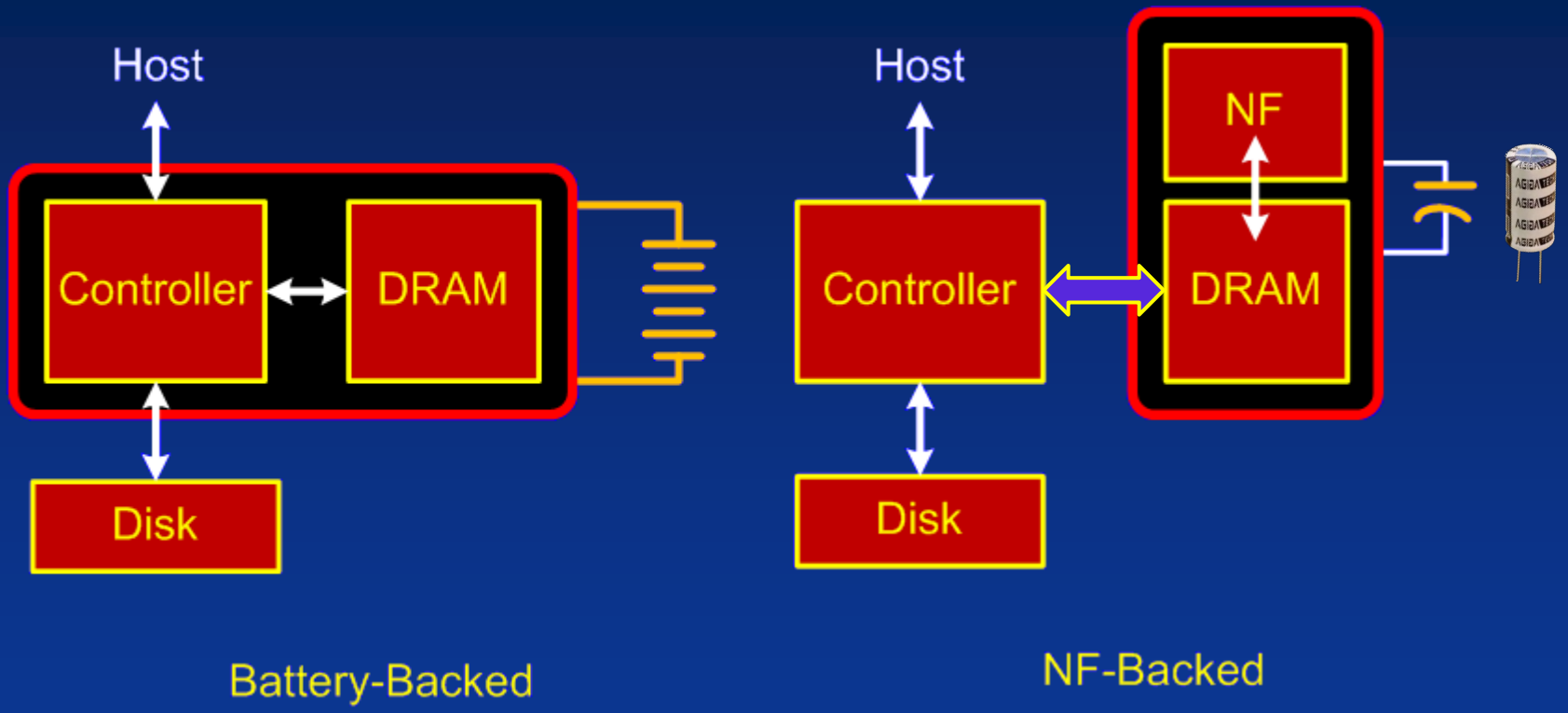
Agenda

- NV cache methods
  - Battery-Backed DRAM
  - NAND Flash (NF)-backed DRAM
- New power source: UltraCaps
  - How they work (+Demo)
  - Test Data
- In-System Advantages
  - Ultracap charge/discharge curves
  - Unmanaged NF
- Summary

Battery-Backed RAM and Flash-Backed RAM



Capacitor Evolution

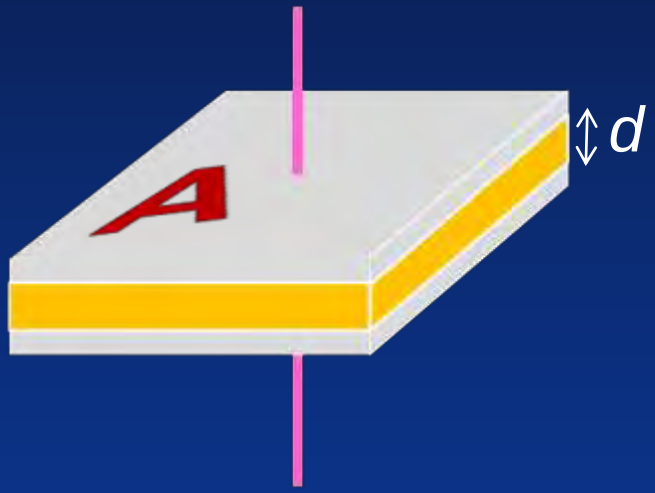
0.001 Farad

~4X Volume…
33,000X Capacitance

33 Farad

How is this possible?

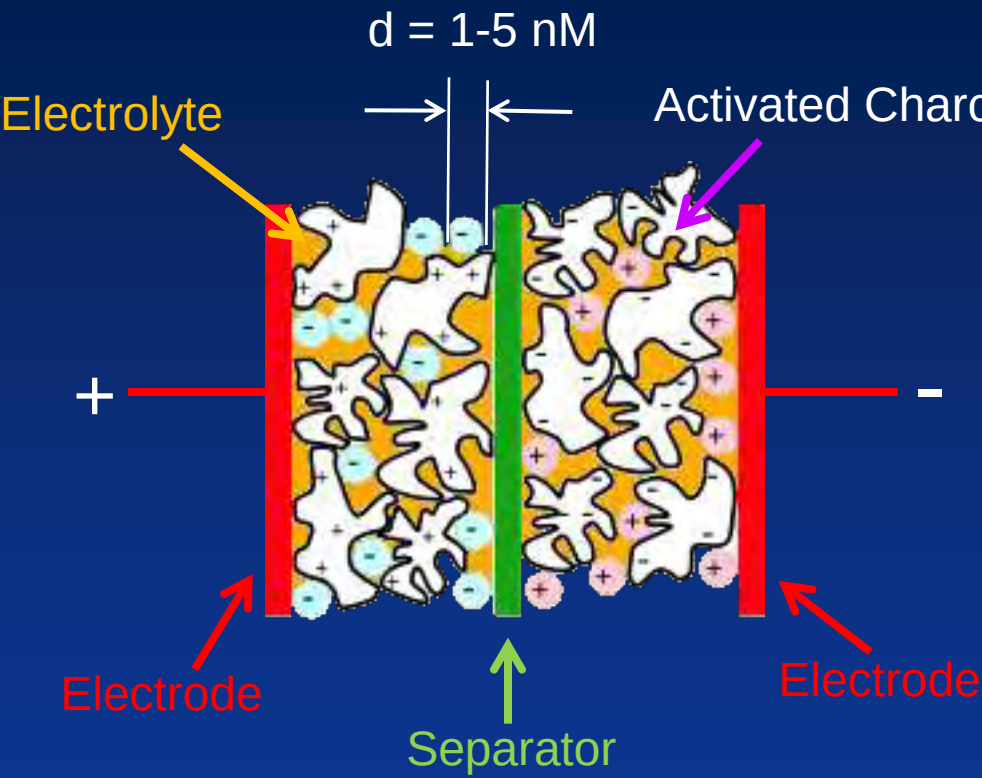
Standard Capacitor



$$C \propto \frac{A}{d}$$

Electrochemical Double-Layer Capacitor (UltraCap)

$$C \propto \frac{A}{d}$$



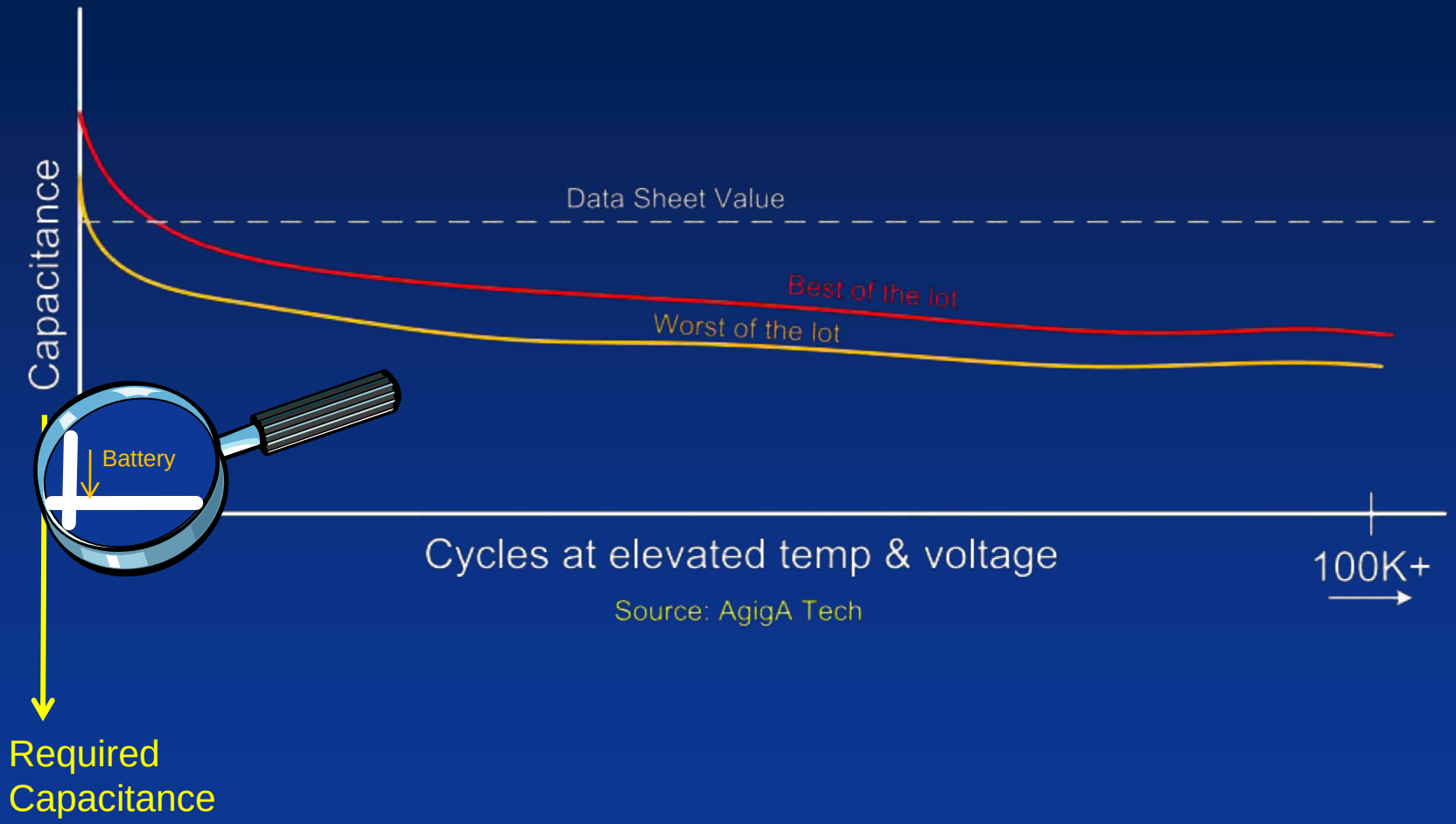
A =1K-2K m^2/g

Demonstration

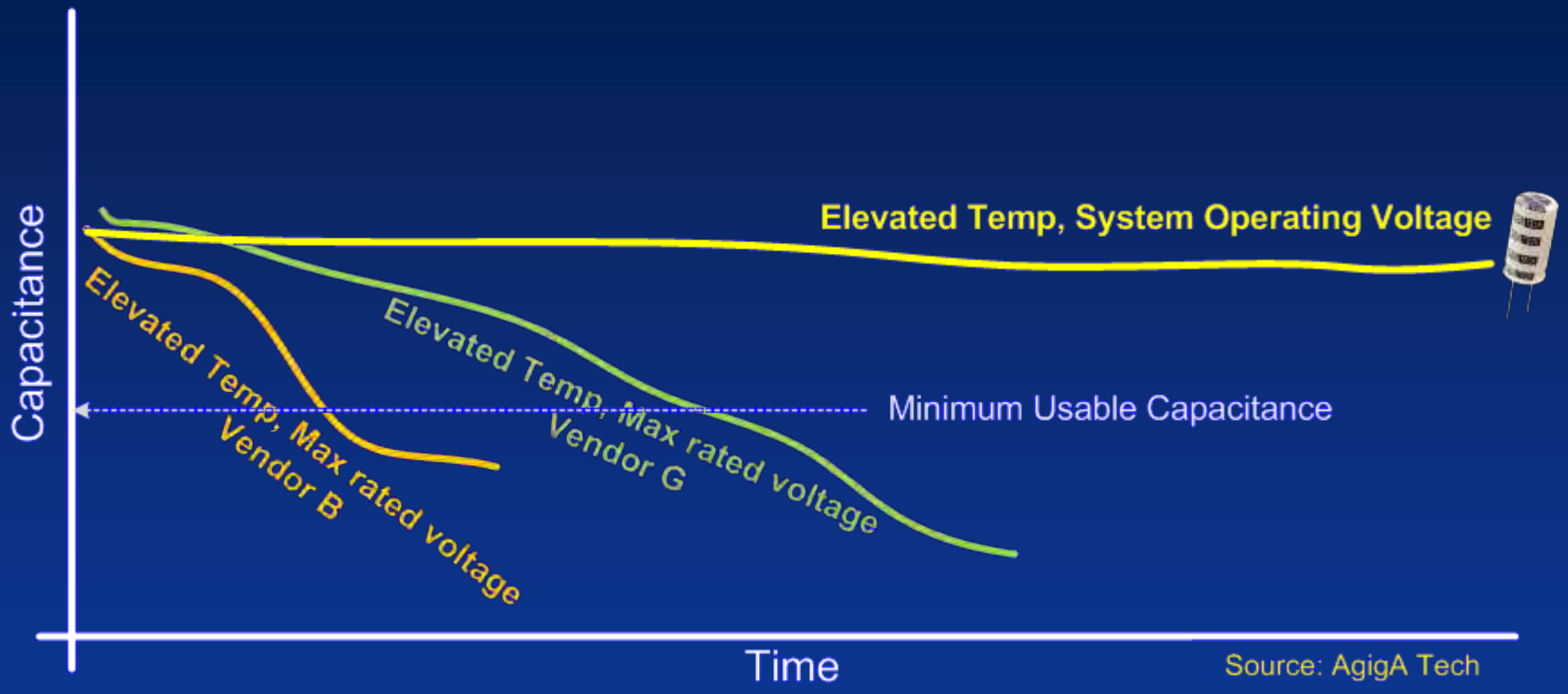
UltraCap Reliability Testing

Supercap Test Board

Charge/Discharge Cycles

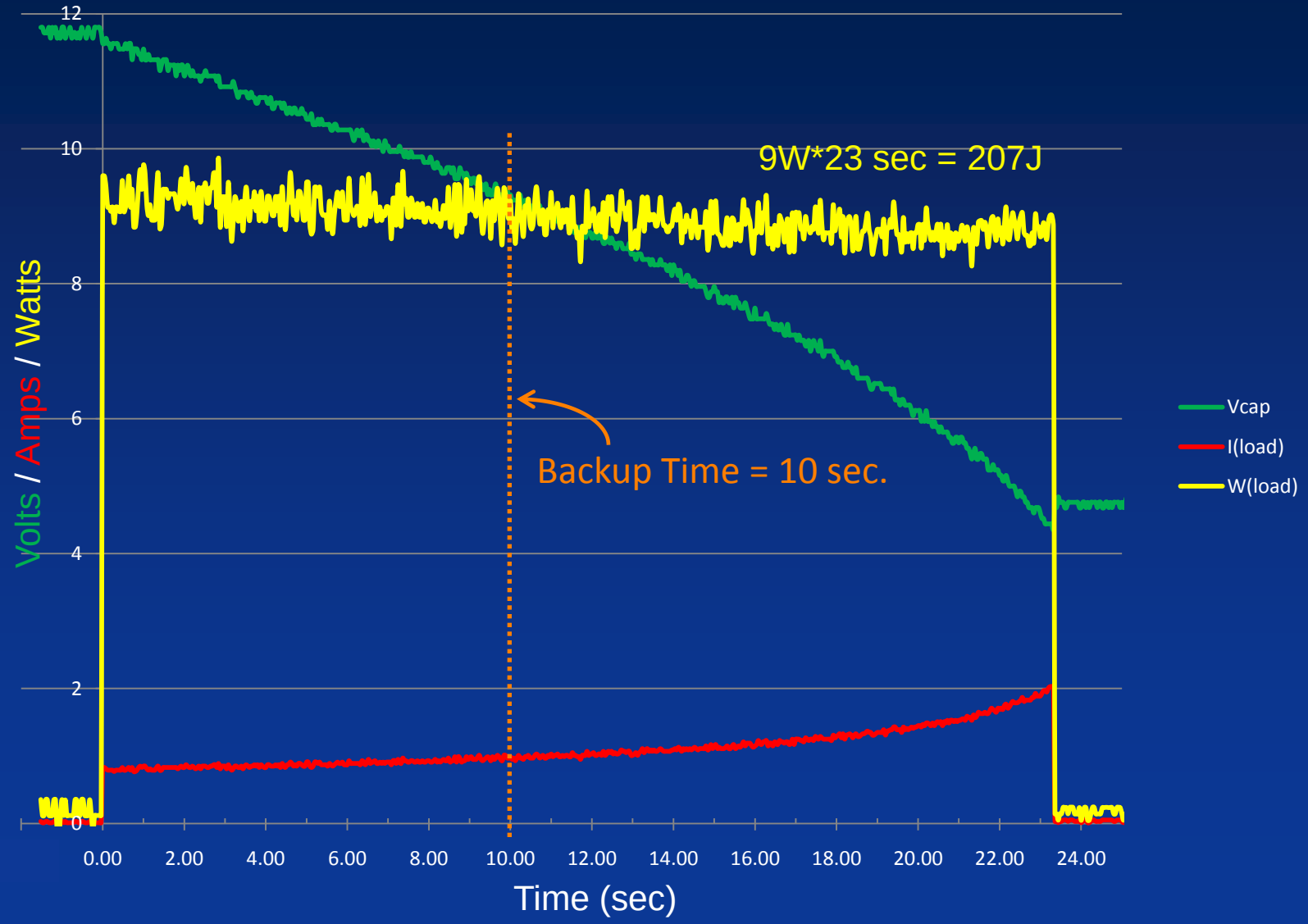


Voltage & Vendors

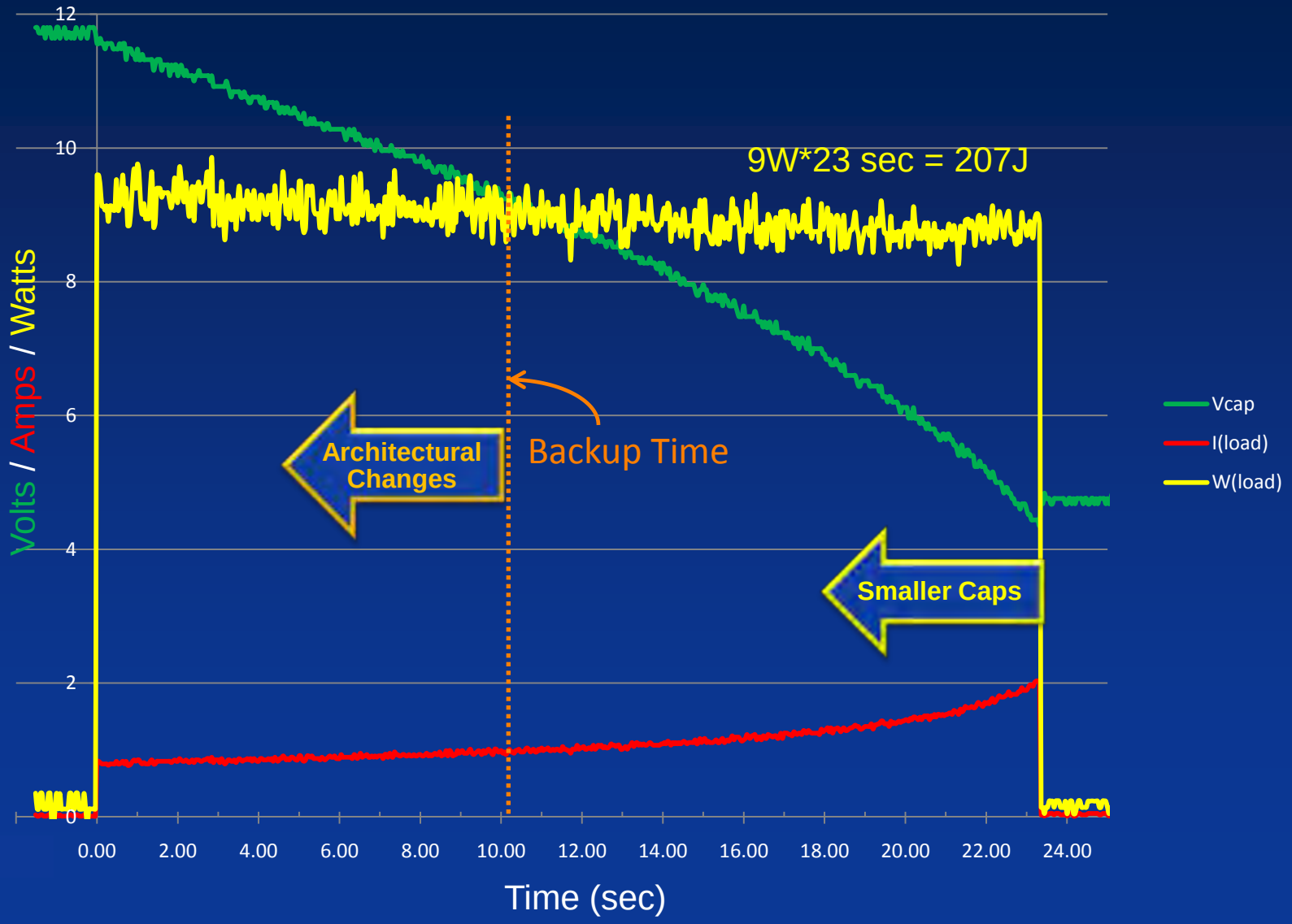


"All date taken at same elevated temp, well above spec limit.

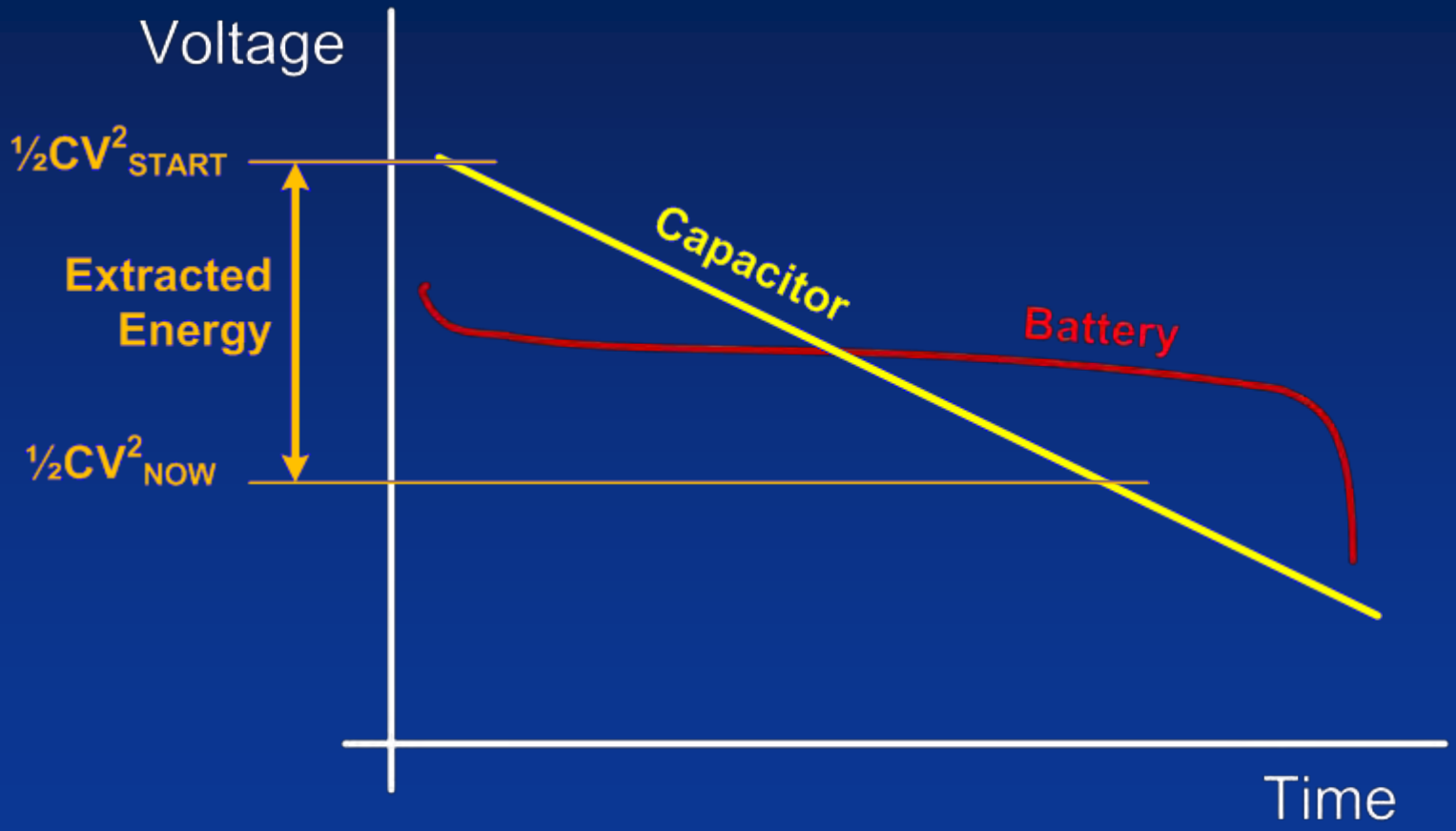
In-System PowerGEM™ Energy Measurement



Tradeoffs


12
10
8
6
4
2
0
Volts / Amps / Watts
9W*23 sec = 207J
Architectural Changes
Backup Time
Smaller Caps
Vcap
I(load)
W(load)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
Time (sec)

Reliability: How Much Energy?



Other Reliability Issues

- Unmanaged Flash Has Advantages
  - Low-level visibility can give early warning
  - Wear tracking can be made available to host
  - Trending over service lifetime
- SuperCap-powered system remains powered when host loses power
  - Safety Interlock Signals
    - Host can glitch signals during power up/down
    - Qualifiers (Enables) require normally-operating host
  - Complex system readiness reduced to single GTG (Good To Go) signal
    - Multiple readiness factors readable over I^2C registers

Summary

- NF-backed SDRAMS make excellent reliable power-loss protected caches
  - High densities, e.g 1GB-8GB
- UltraCaps are ideally suited to this application
- UltraCaps wear, but not a system issue if properly selected, sized and rated
- Fine control over system “internals” like managing the NF allows precise health monitoring and tracking
- Special attention is required to operate a powered system while its “master” loses power