The Invisible Management of User Expectations

Power Management for Cell Phones

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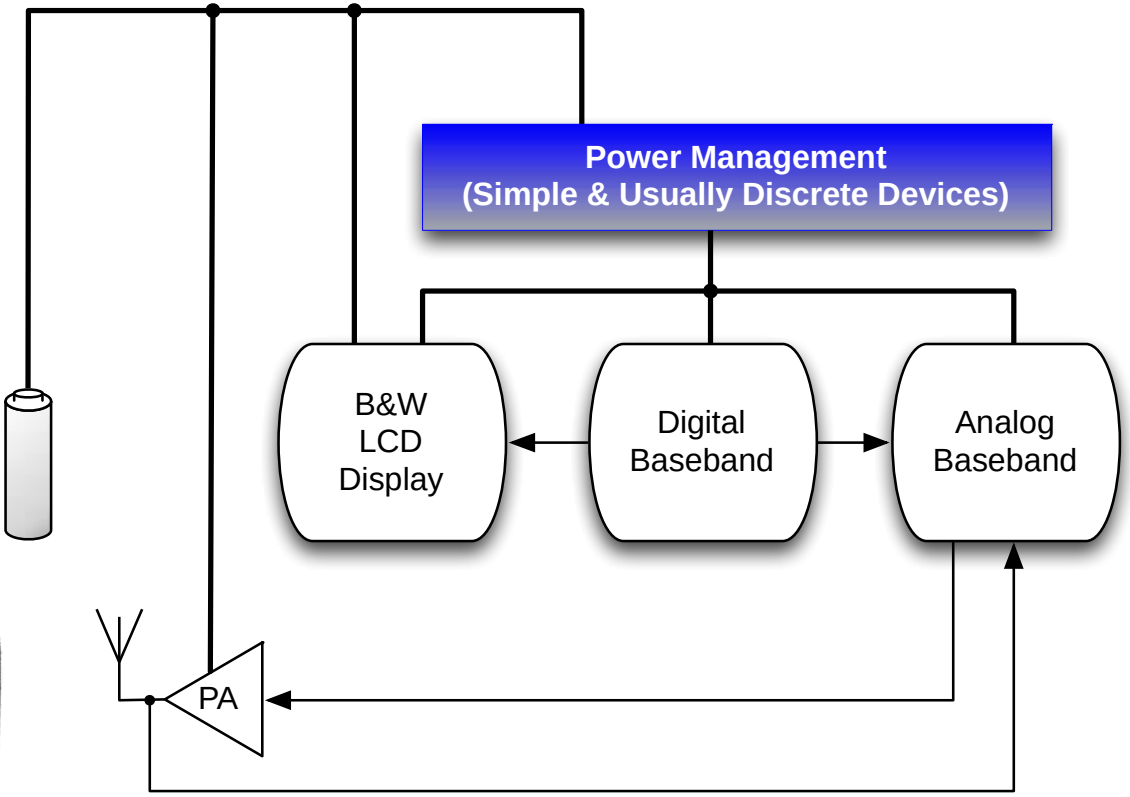
In the beginning…

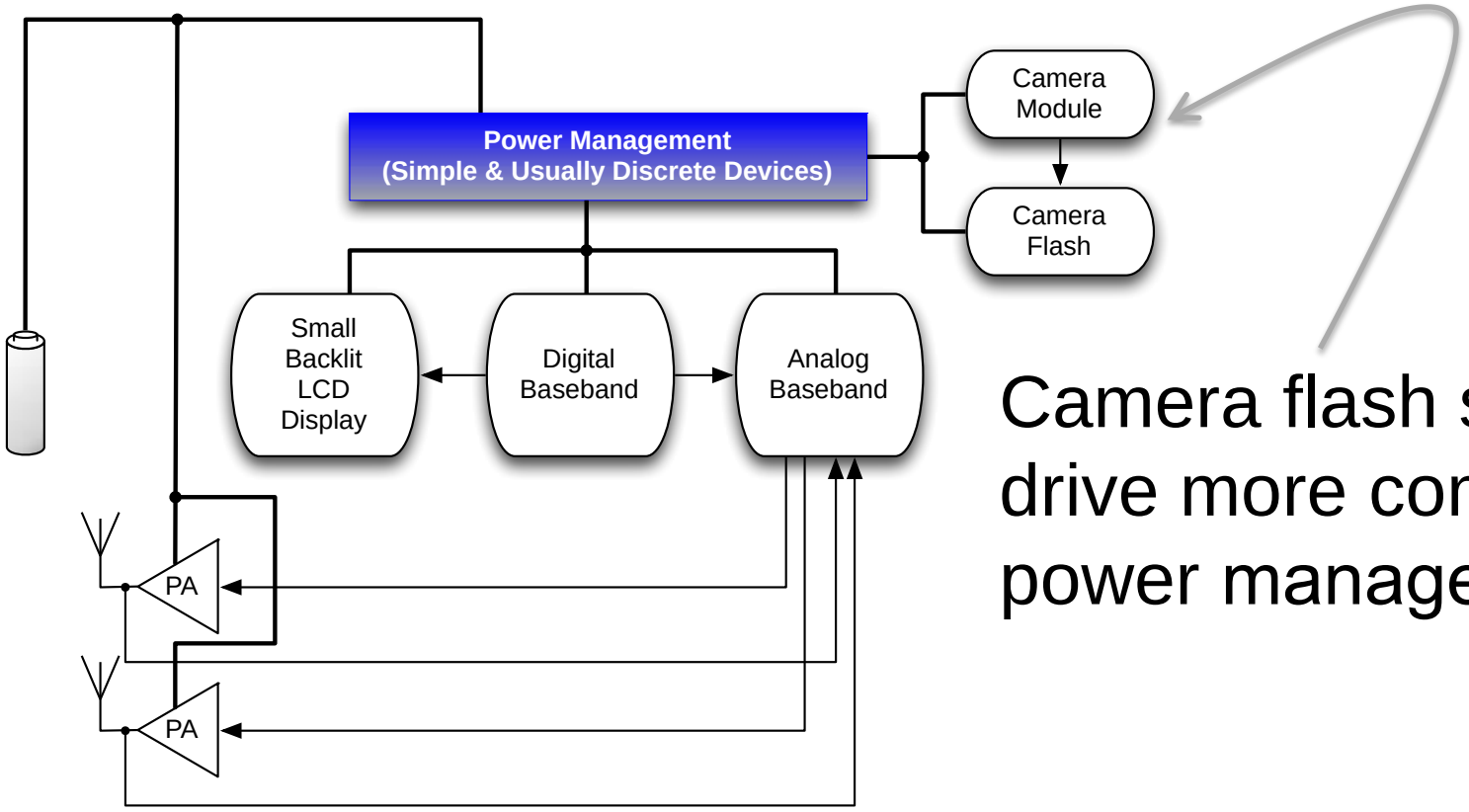
Simple phones



Improvements in battery capacity married with improvements in power dissipation of the basebands led to longer battery life.

Then…

Multi-Band & Camera Phones

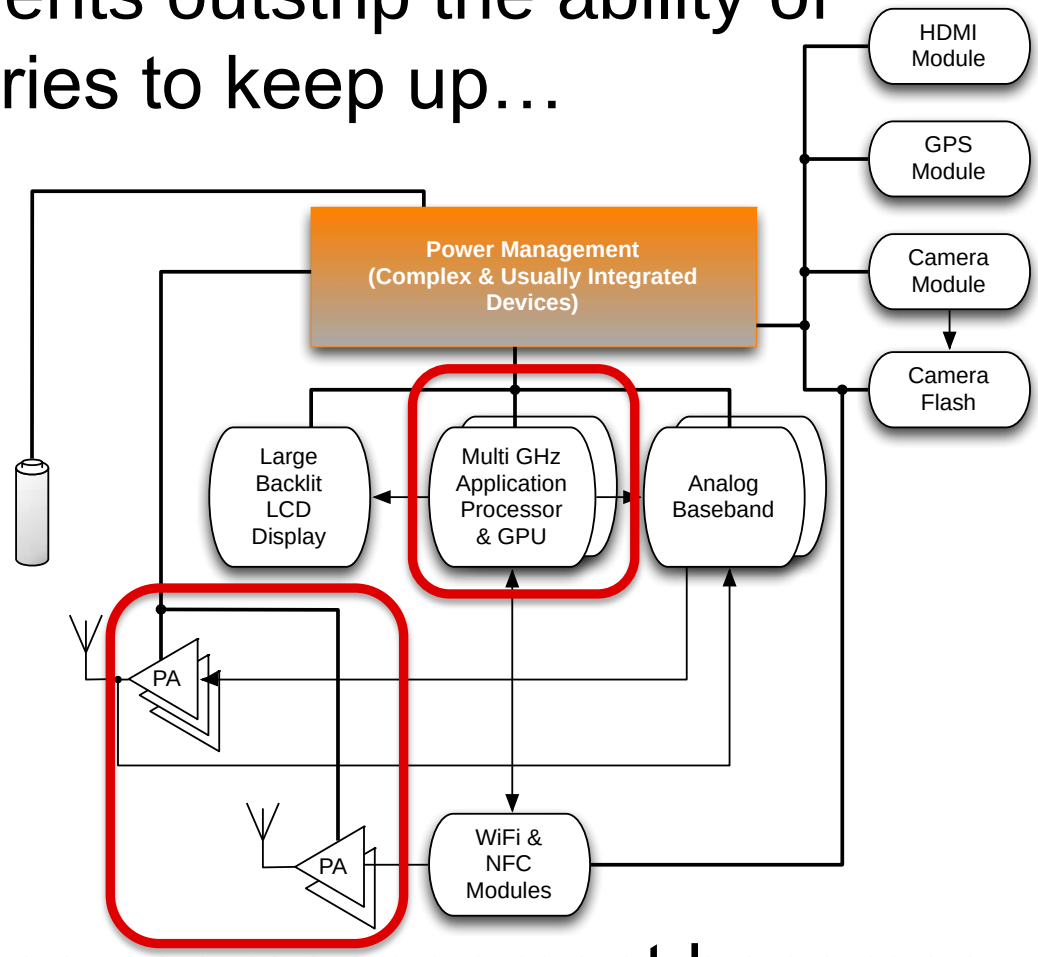


Camera flash starts to drive more complex power management…

…primarily to ensure that the flash didn't impact call quality.

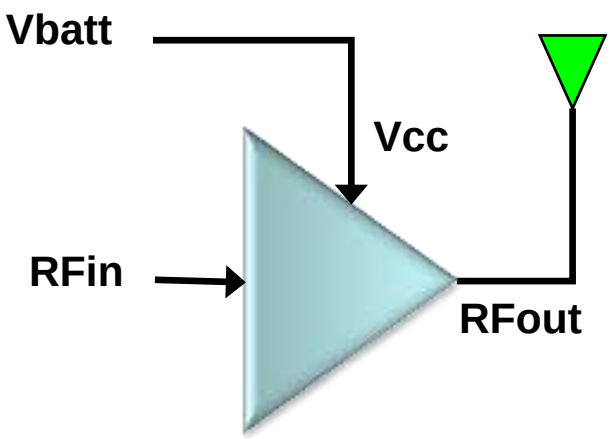
And now…

System Power & Industrial Design requirements outstrip the ability of the batteries to keep up…



…so power management becomes more critical.

Early Power Amp Power Management

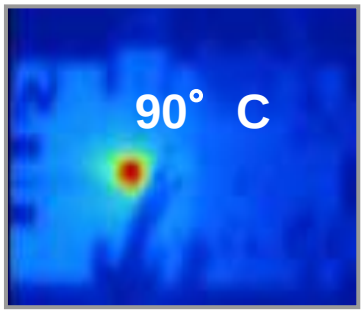


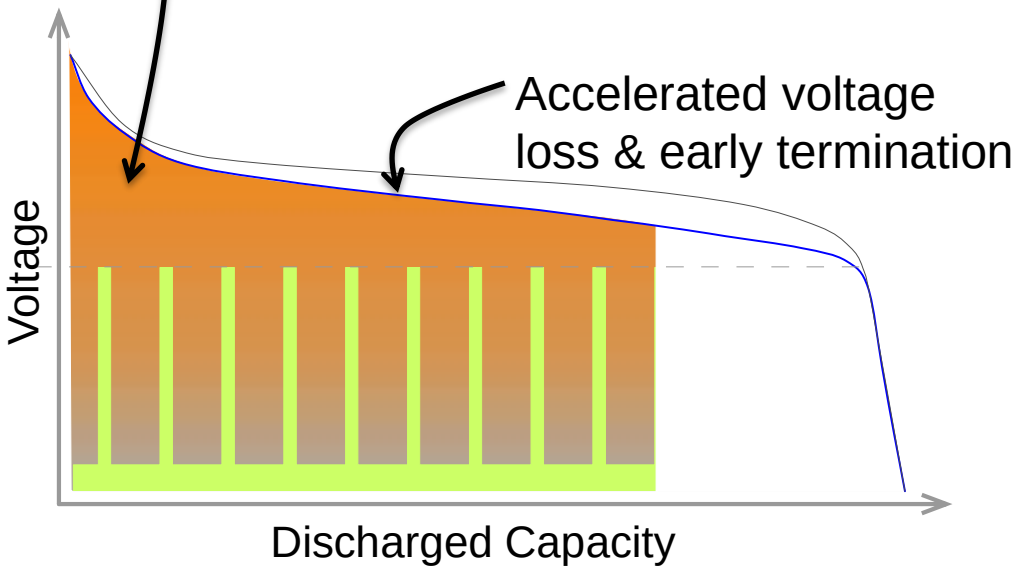
Power Amplifiers (PA) historically were connected to batteries due to noise.

→ low PSRR did not impact performance

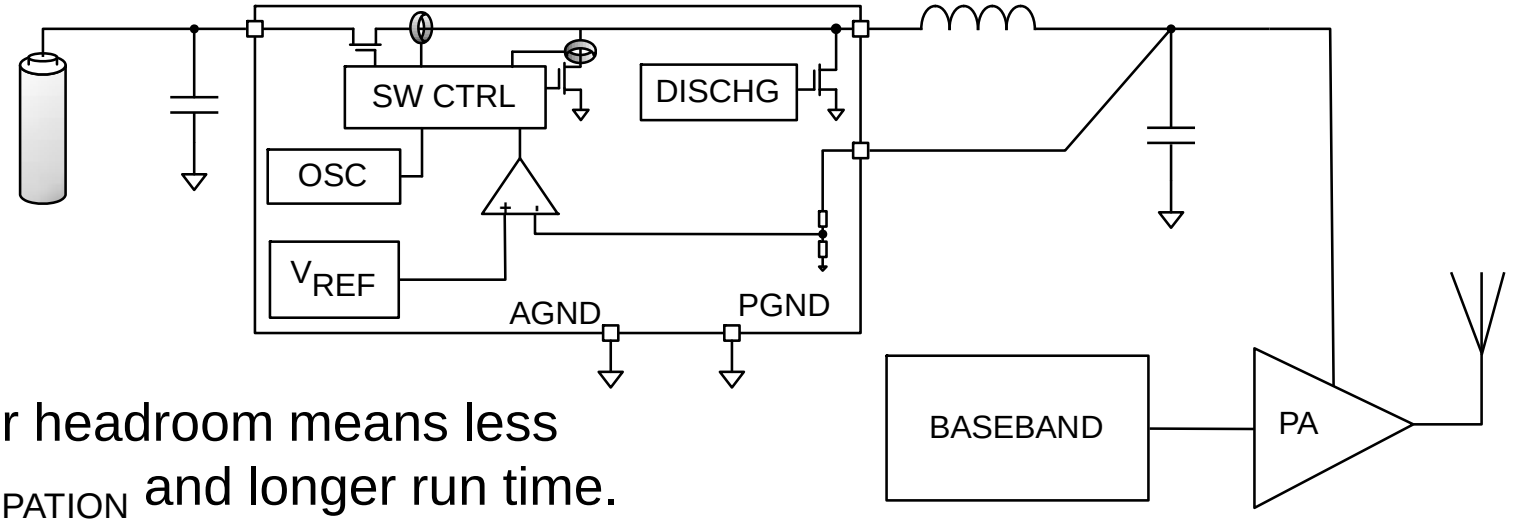
But $P_{DISSIPATION}$ was high.

→Direct impact to run time & heating of unit

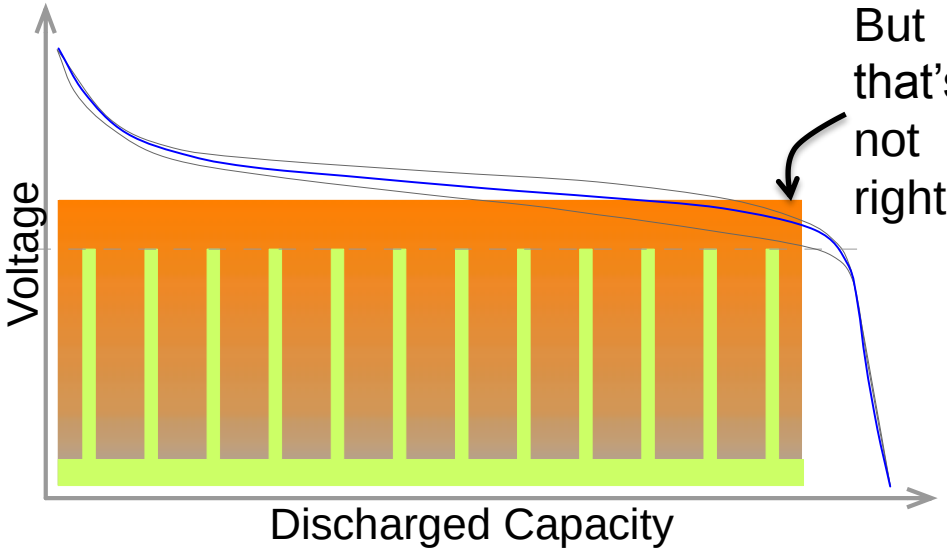




Improving PA System Efficiency…



Lower headroom means less $P_{DISSIPATION}$ and longer run time.



But that's not right!

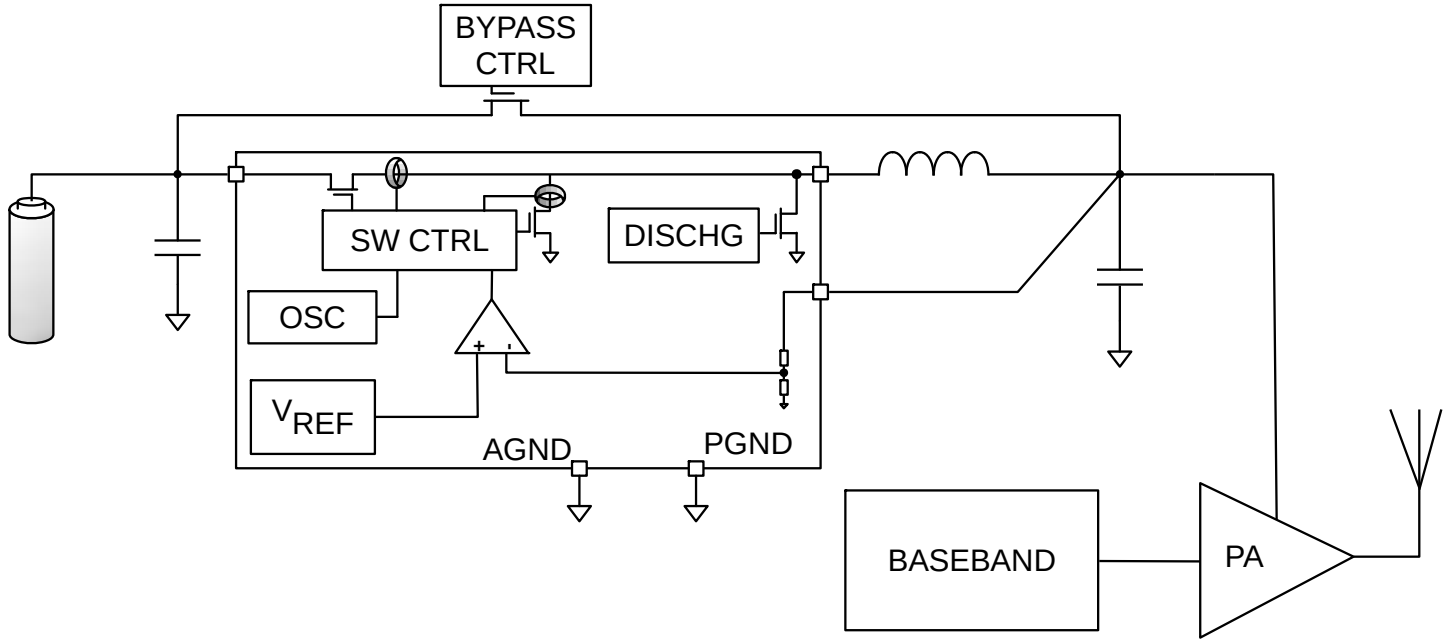
PA PSRR improved a couple of ways:

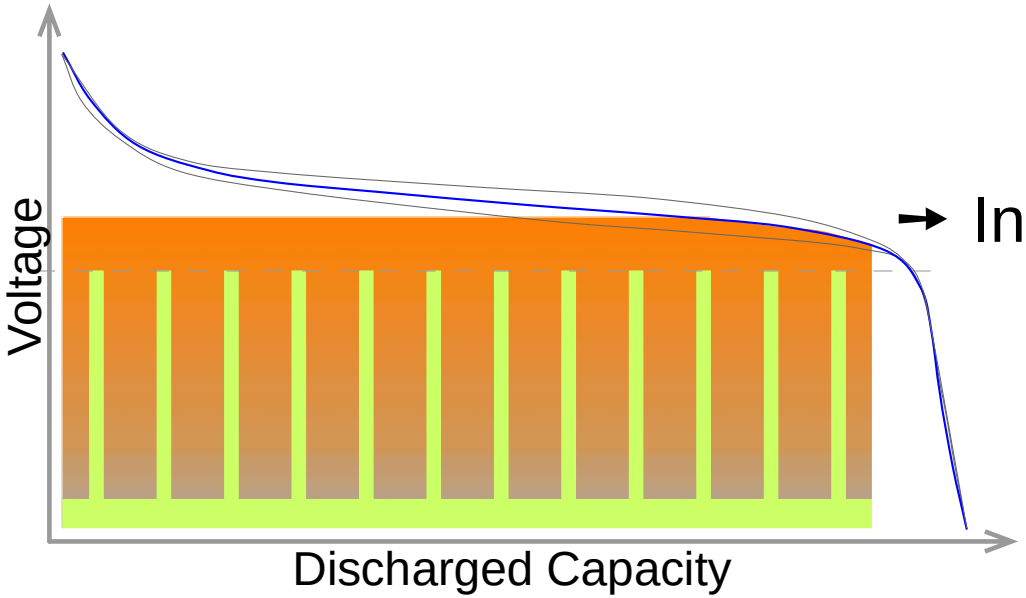
1. Integrated LDOs
2. Better designs

→ Allowed a buck to power the PA

Improving PA System Efficiency…

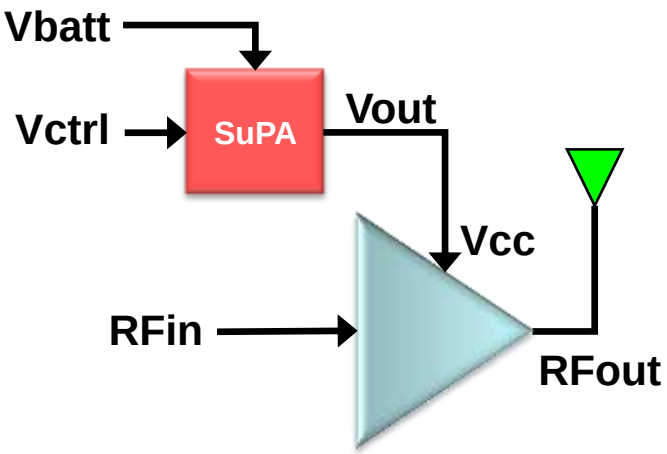
Bypass mode allows a direct connection at lower $V_{BATTERY}$.



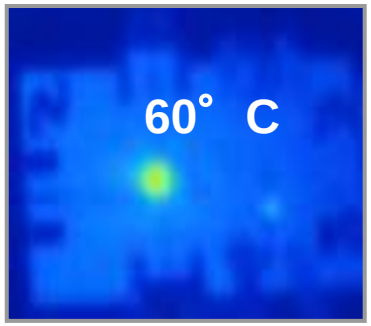


→ Incrementally longer run time.

The Future of PA System Efficiency…

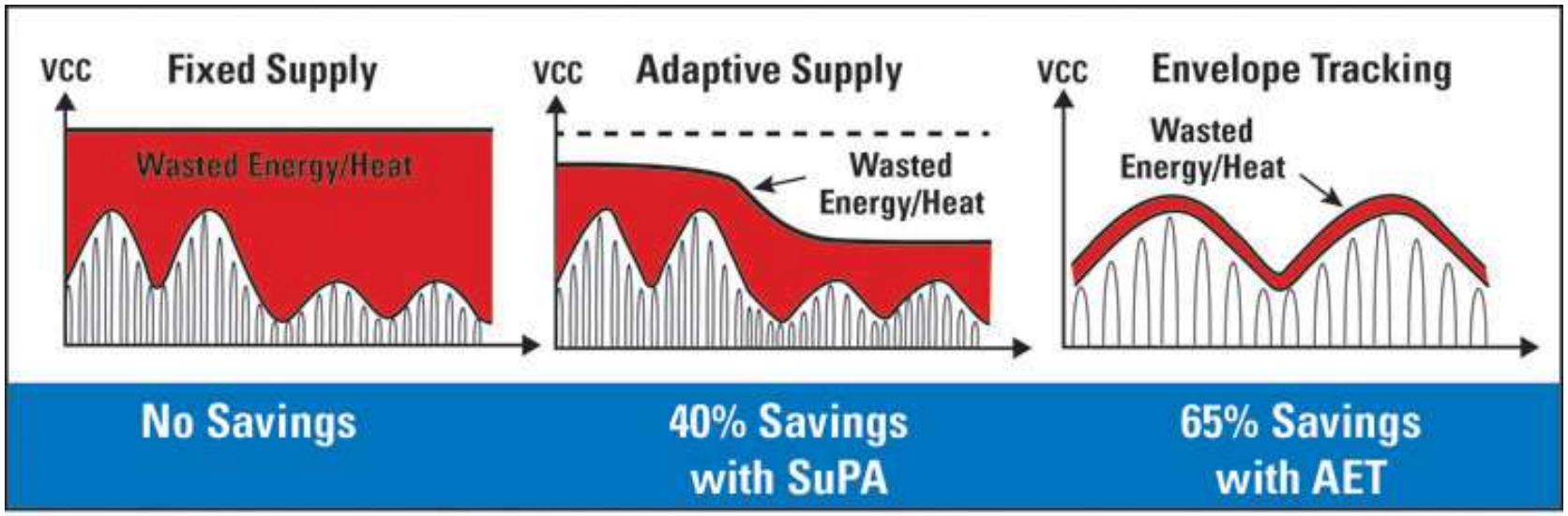


Buck with fast voltage changes allows for “adaptive” supply scenario…



…& married to HS amp to further reduce the $P_{DISSIPATION}$

➞ Envelope Tracking



And what about the processors?

$$P_{Total} = P_{Active} + P_{Leakage}$$

$P_{Active} \propto V^2 f$

Higher frequency requires higher voltage

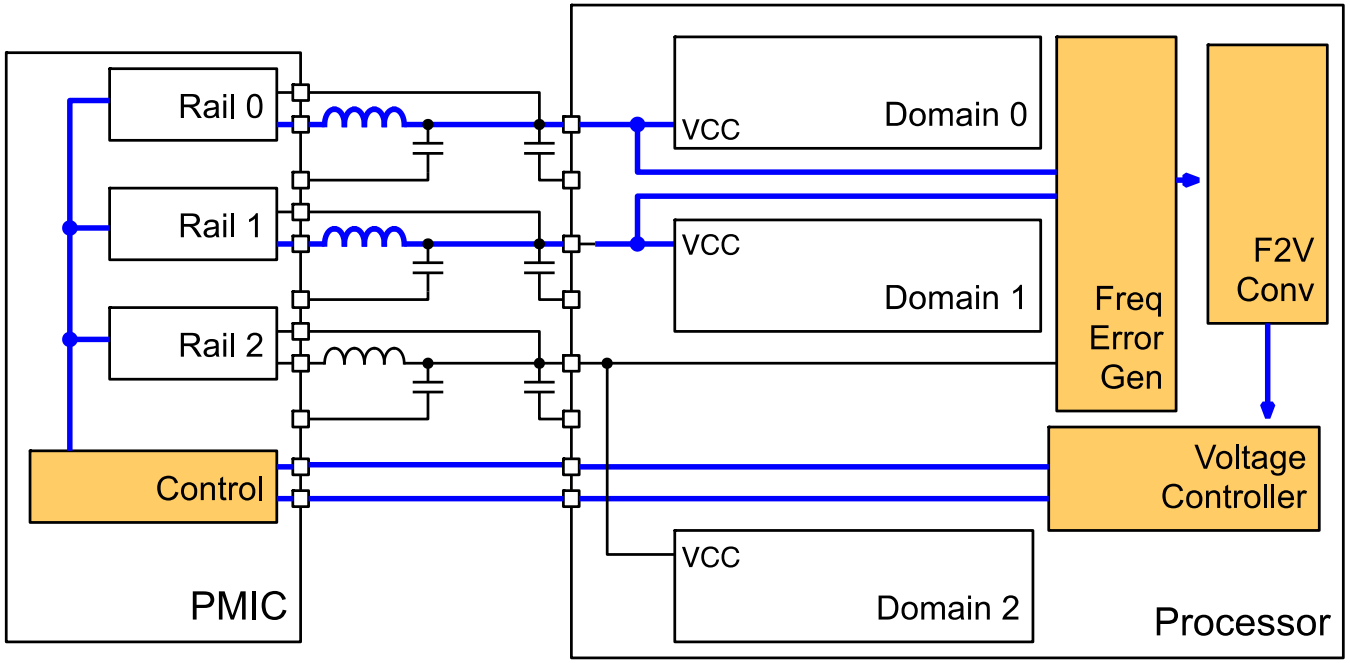
$P_{Leakage} \propto V$

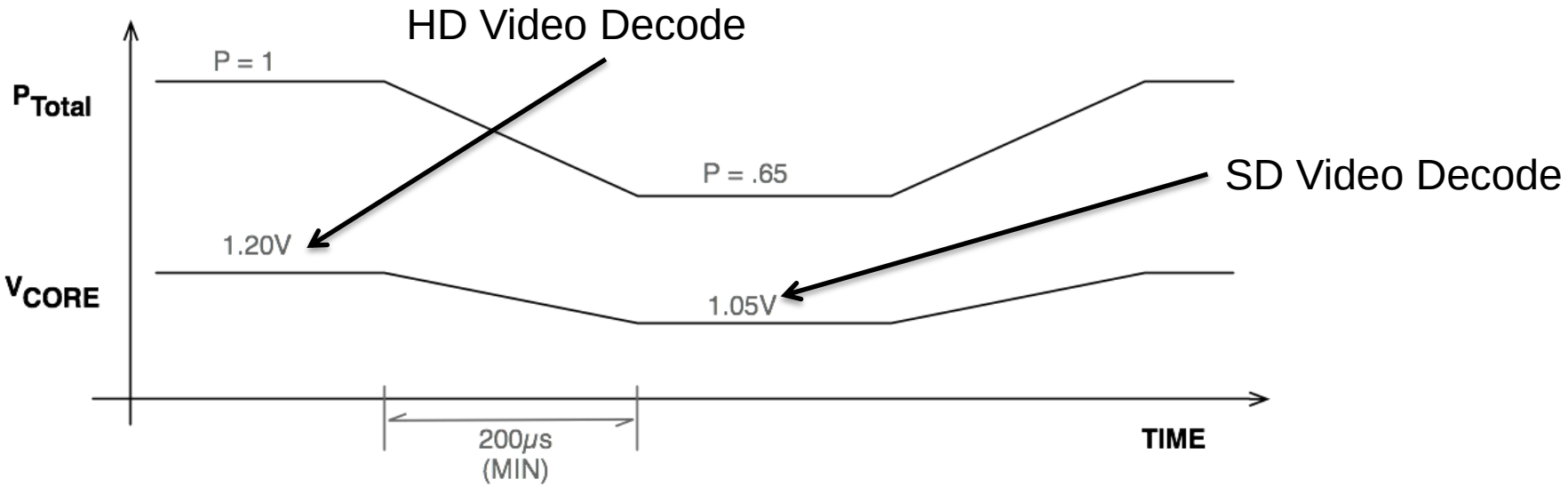
Shorter geometries require less voltage, but tend to have higher leakage

Processor	Peak Frequency	
ARM7	55MHz	
OMAP1	168MHz	1.05 – 1.3V
OMAP2	330MHz	
OMAP3	1200Mhz	
OMAP4	1800MHz	0.9 – 1.35V
OMAP5	2000MHz	

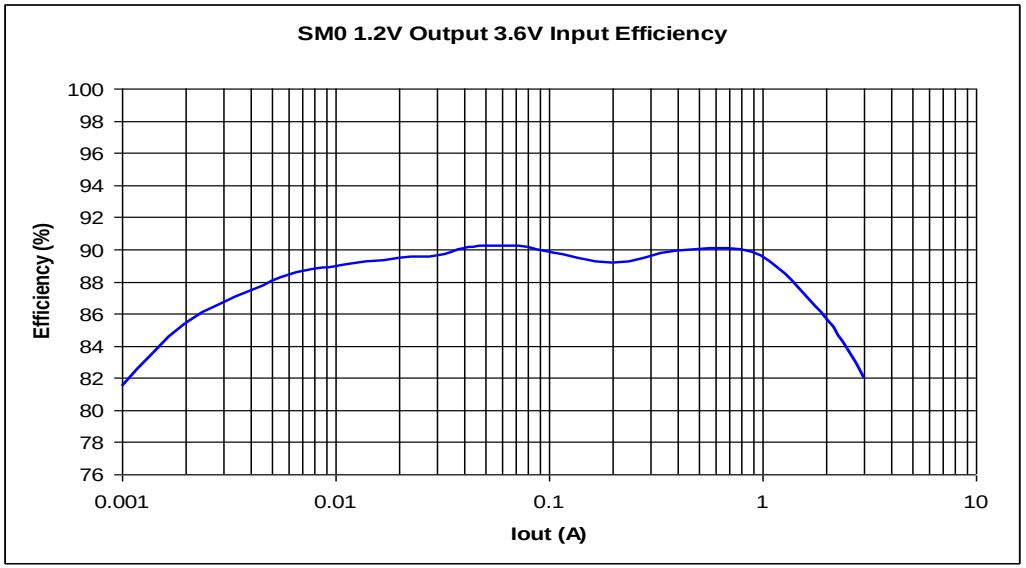
Active Power Reduction…

Closed loop power supply control to ramp voltage up or down based on operating point.





Dealing with wide current ranges…

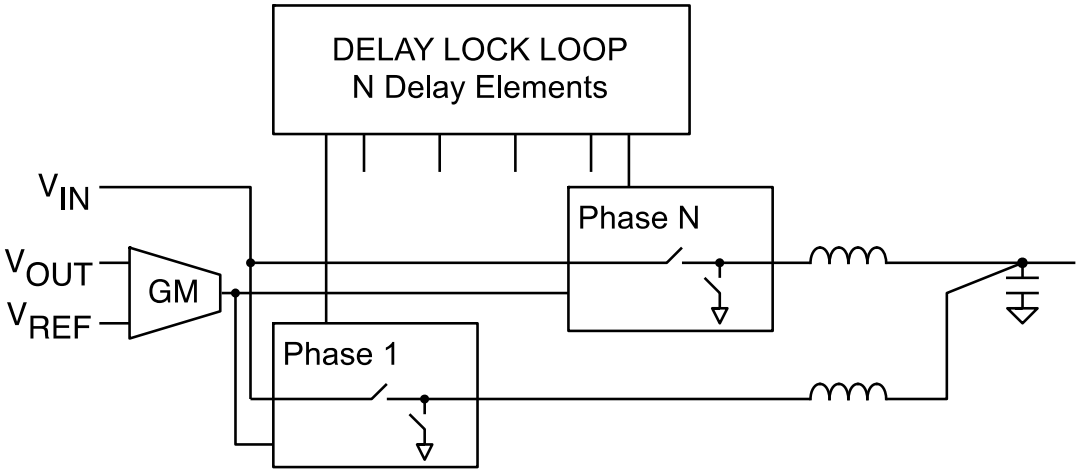


Segmented FETs:

- A comparator array senses the current across the high side FET & automatically adjusts the number of FETs on to improve high load efficiency.
- 1 inductor → Size Tradeoff

Multi-Phase:

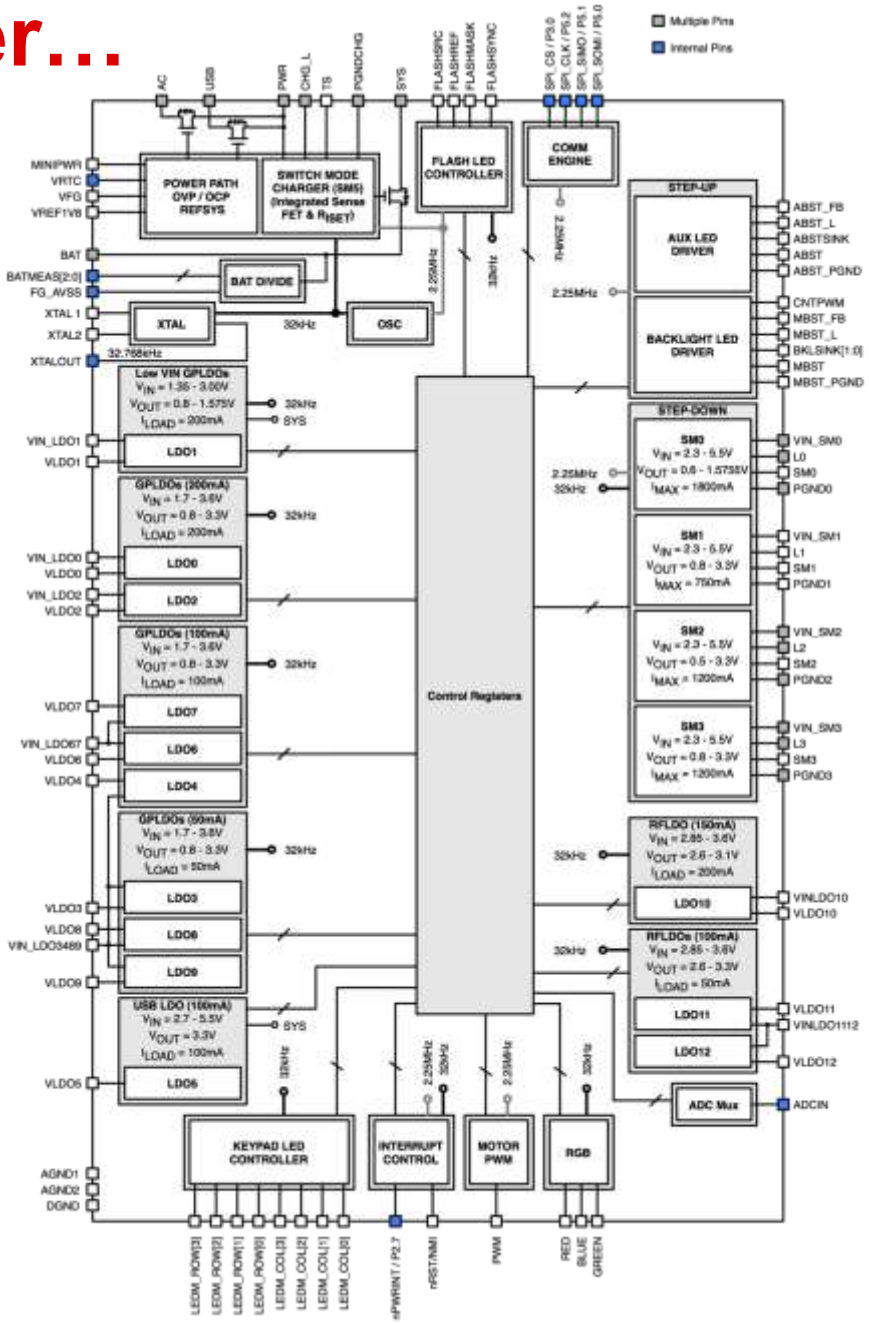
- Similar to segmentation, but each phase has its own controller which is enabled as needed.
- Requires multiple inductors, allowing for choice of smaller inductor



Bringing it all together…

Power Management ICs do not have to be just single chips, they can be the combination of a number of these techniques.

As with all engineering challenges, there are tradeoffs.



Thank you for your time