Optimizing Embedded SSDs: One size doesn't fit all

Prevention-Report-Analysis

Flash Memory Summit 2016

ATP Electronics, Inc.

Agenda

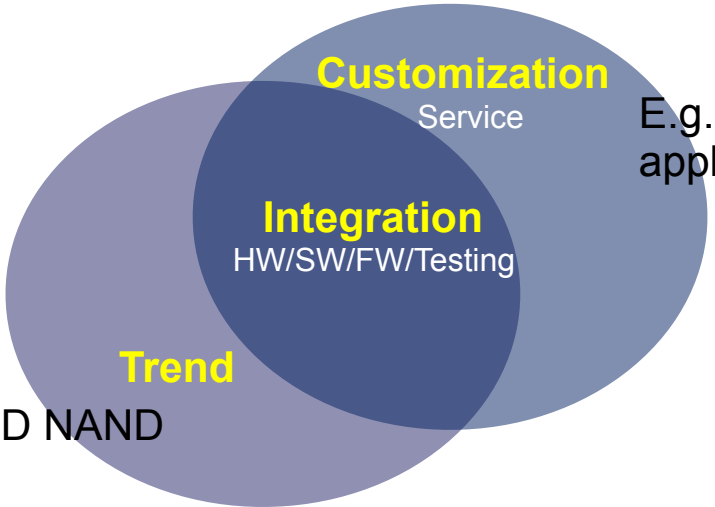
- Overview
- Embedded Applications
- Moving to 3D NAND
- The Power of Synergy - Integration
- - Scenario 1 : Optimizing performance
- - Scenario 2 : Power Issues
- - Scenario 3 : Temperature Impacts
- Customization

One size doesn't fit all - The power of Synergy

Myth - "Killer feature", "More is better"?

Reality - One size doesn't fit all, especially for industrial business

No killer feature can solve all problems due to various **use models, applications, and requirements**

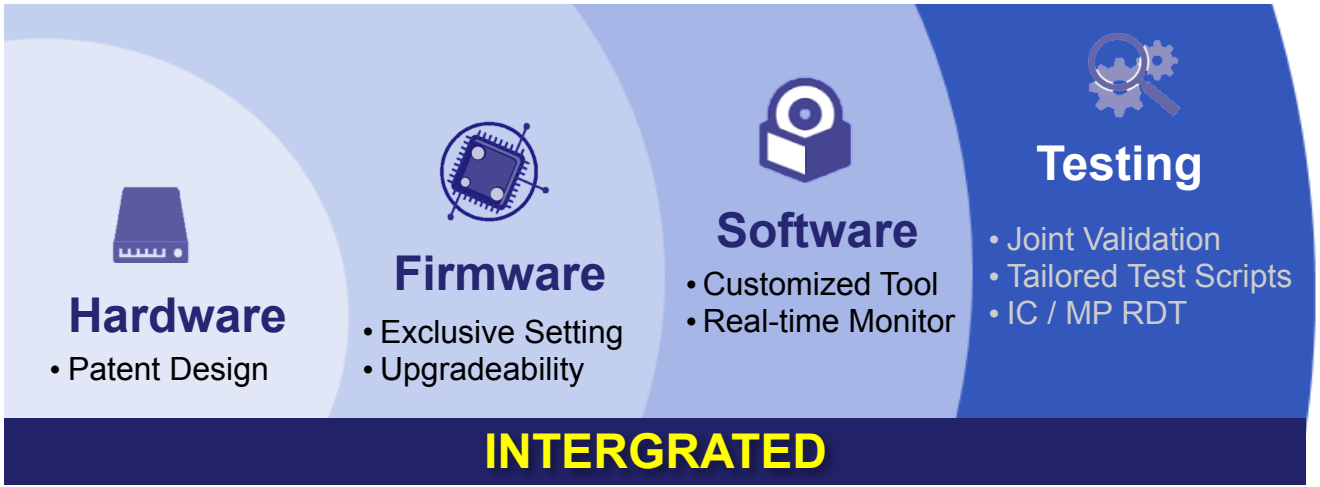


E.g. Embedded applications

E.g. 3D NAND

Integration - The Power of Synergy

Seamlessly integrated state-of-art technologies with early validation makes **Preventing-Reporting-Analyzing** mechanism fully realizable.



Embedded Applications

Field Experiences in Embedded Applications…

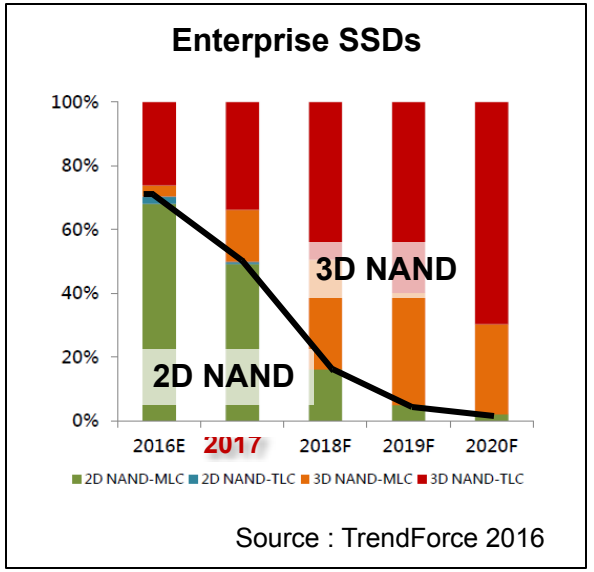
1. Clients are interested in real-time performance
2. Most workloads are random in nature
3. Real usage :
   - **SSD as boot drives or storing application programs**
     - **Read applications**
   - **Data logging for a small set of tasks**
     - **Smaller density requirements, smaller file size data transfers**
   - **New O/S support 4K/sector architecture**
     - **4K random read/write is the key performance indicator**

Moving to 3D NAND…

- **Driven by big data / cloud computing / data center …**

- **Suffering …**
  - NAND Technology : Shrinking Lithographies
    - (2D, now approaching its physical limits)

  - **Customers' pain points :**
    - **Mass storage within Limited spaces**
    - **High Performance at the lowest Cost**



Moving to 3D NAND…

- **Mainstream focuses:**

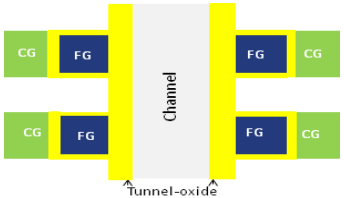
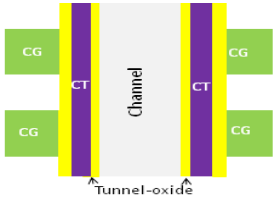
  - Greater Storage Capacity (Terabytes)
  - Higher Performance (IOPS ; MB/s)
  - Access Latency (µs)
  - Endurance (DWPD)
  - Power Consumption (W)
  - Cost

What about the real concerns of embedded applications?

- ? All of above (asking for large density?)
- ✓ Data Retention? Read disturb?
- **What else?**

Moving to 3D NAND…

- **FGF/CTF…What's better for your embedded application?**

	Floating Gate Flash	Charge Trap Flash
		
Endurance	Spec 3K P/E cycles (the real endurance may reach 10K~30K P/E cycles with LDPC)	Better
Read/Program Disturb	Less impact	
Data Retention	Better	

Read-intensive application

(source: FMS 2015 IBM)

Moving to 3D NAND…

- **"More" should be taken into considerations…**

- **Performance issues**
- → Capacity demands (low density) do not change
- → But the performance has certain prerequisites (High random 4K IOPS)

- **Power issues**
- → Power efficiency
- → Power failure Protection / Power Risk Management

- **Temperature impacts**
- → Reliability in industrial Temperature (-40℃~+85℃)
- → High temperature vs Data Retention

The Power of Synergy

Scenario1 : Optimizing performance

Tendencies

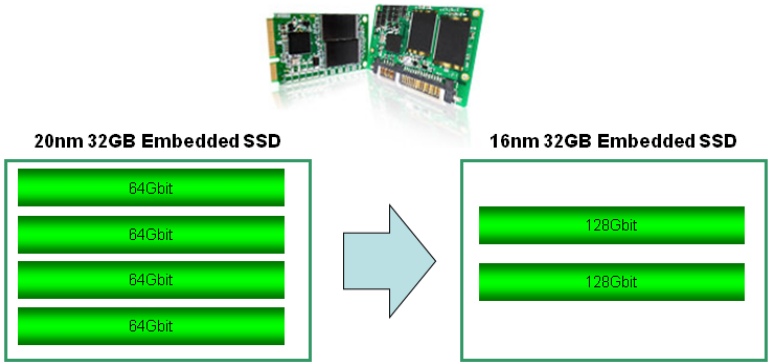
NAND Flash Evolution

→ Dies density growing to pursue larger density for cost/GB

Embedded applications

→ Performance can't be compromised

Scenario1 : Optimizing performance



The Power of Synergy

Scenario 2 : Power Issues

Tendencies

NAND Flash Evolution
→ Better power efficiency of 3D NAND?
→ Real testing data: Power consumption of 3D NAND is larger than that of 2D NAND (especially the peak current)

Embedded applications
→ PLP (Power Loss Protection) has became the hard requirement in most cases
→ Built-in capacitors in one of the approach
→ No Industrial standard or criteria of PLP

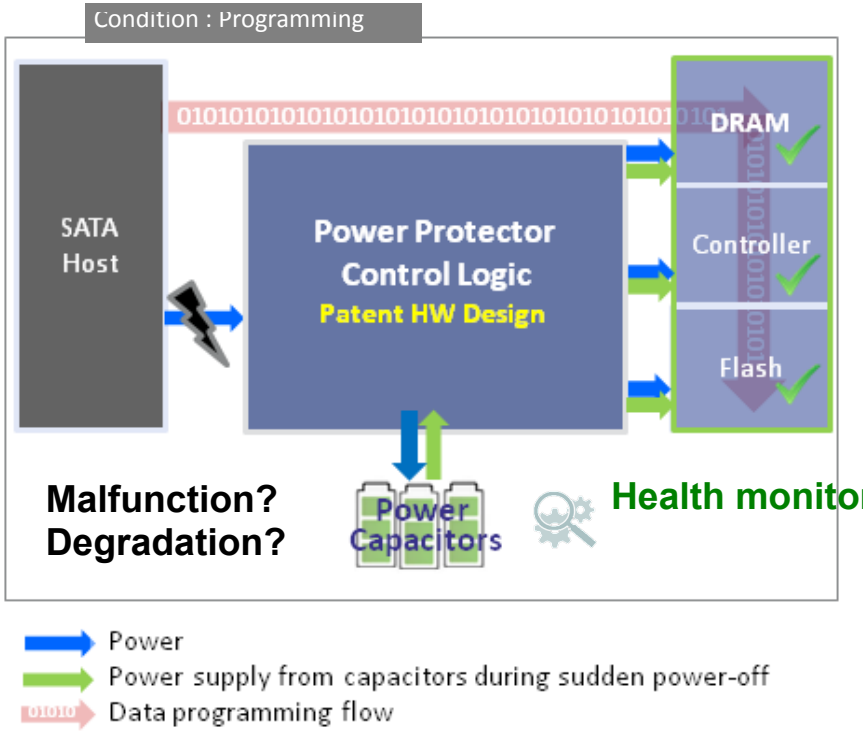
The Power of Synergy

Scenario 2 : Power Risk Management

Power Protector Control System

Variable design features important for PLP reliability

- Self-contained power protector
- The type of capacitors
- Broader coverage (controller/DRAM cache/NA flash)
- Overvoltage and overcurrent protection
- Power capacitor self-test mechanism
- Capacitor life monitoring



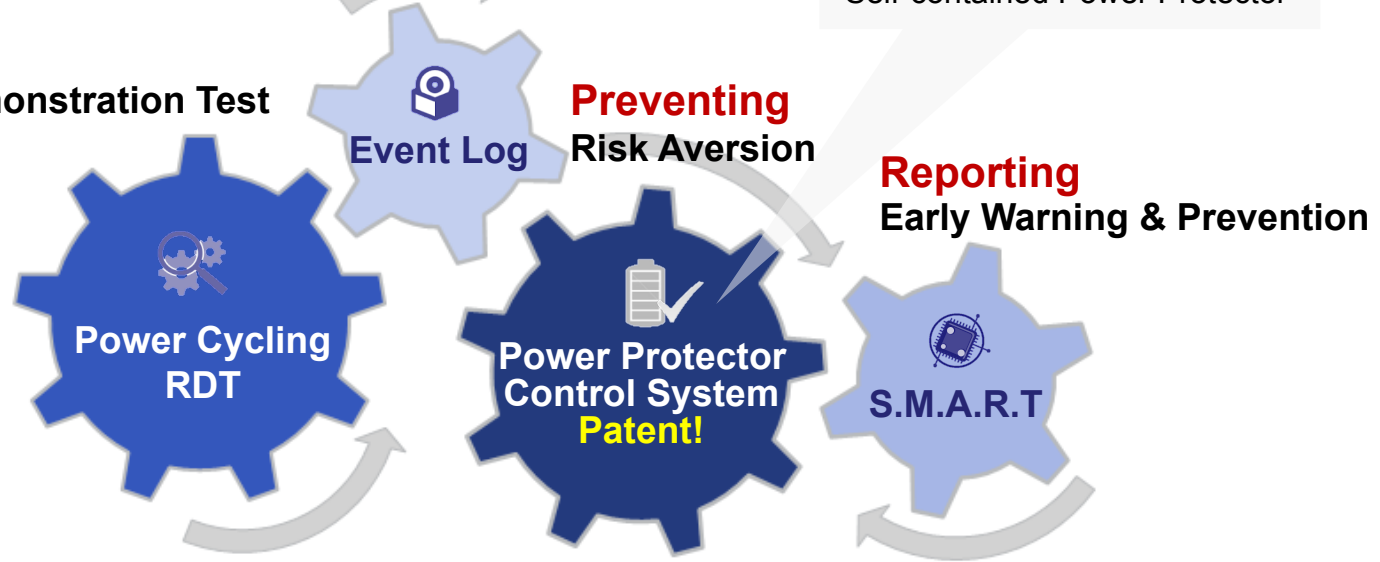
Prevention (the ultimate objective)

How it works? Evidence!

Analyzing (debugging)
Double confirms no UECC

- Capacitor Self-test Mechanism
- Self-contained Power Protector

Validation
Reliability Demonstration Test
(> 5000 cycles)



Preventing
Risk Aversion

Reporting
Early Warning & Prevention

The Power of Synergy

Scenario 3 : Temperature Impacts

Tendencies

NAND Flash Evolution

→ The reliability & data retention of 3D NAND?

High temperature V.S. NAND characteristics: Testing to understand the NAND nature?

Embedded applications

→ Require Industrial Temperature (-40℃~+85℃)?

→ Heavy workloads

→ Limited space with heat dissipation issue

→ Running 24/7

The Power of Synergy

Scenario 3 : Temperature Impacts

Conditions

- Constraint space with heat dissipation issue
- Heavy workloads
- Long-period operation
- High host device temp.

Result in…

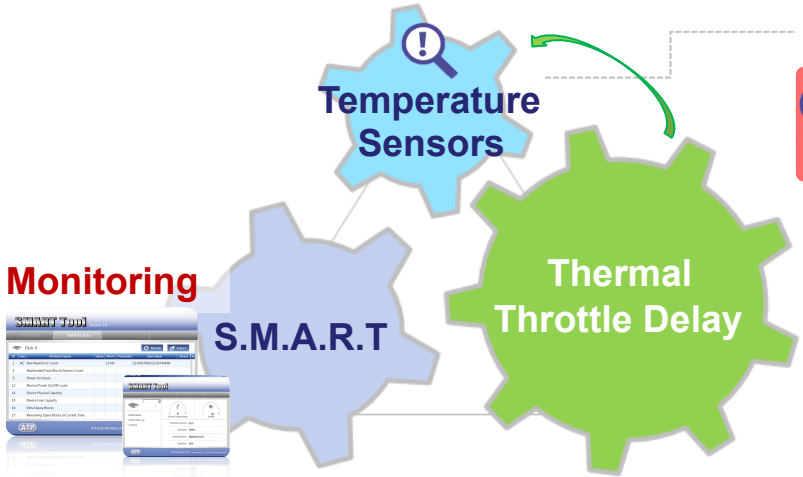
Controller / NAND Overheating

Risks

- Data loss
- Commands misinterpreted
- The OS can't be accessed
- Fail/Dead flash drive
- Malfunction

Prevention (the ultimate objective)

How it works?



Detecting - Controller Temperature

Heating up to "threshold" — ACTIVATION — **Cooling down** to normal operating temp.

Activating - Thermal throttling mechanism

Speed throttling to avoid catastrophic temperature levels and to mitigate the risk of the controller overheating

Customization

Optimizing SSDs? Power of Synergy

Well Integrated & Built your specifications

- **TCO Evaluation**
  Evaluate the total cost of the solution (values), rather than the purchase price alone
  (BOM control, replacement, field return, reputation…etc)
- **Product Customization**
  Hardware design /Firmware setting/ Custom Label
  Customizability of S.M.A.R.T attributes for specific customer analysis/debug/use case
- **Validation**
  Tailored Test criteria with specific scripts/software
  Joint Validation & Qualification to ensure reliability during the life cycle of the product

Summary

One size doesn't fit all
Pick out what you really need based on your application!

- ✓ There are no killer features, only the feature that can fit your applications or not.
- ✓ Moving to 3D NAND…more influences should be counted.
- ✓ Integration (Synergy) : Prevention-Report-Analysis
  A cycle of prevention-report-analysis for risk management and continuous improvement
- ✓ Optimizing SSD : meet requirements with low TCO

Thank you !

Crystal Chang
Senior manager of Strategic Marketing, ATP Electronics, Inc.

Visit us @ Room 205

ATP Website : http://www.atpinc.com/
LinkedIn : https://www.linkedin.com/company/atp-electronics
Google+ : https://plus.google.com/+Atpincelectronics