Virtium
Solid State Storage and Memory

Intelligent Secure Storage
for Industrial IoT

Creating Reliable Embedded Systems with Flash Memory

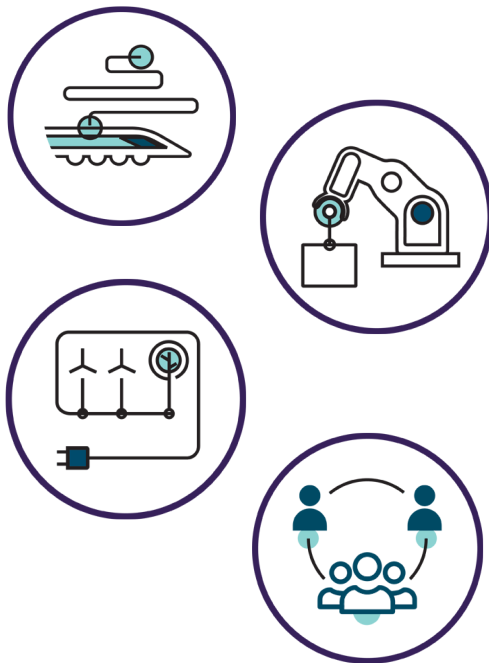## Design Tools for IoT Storage

Scott Phillips

VP, Marketing

The Market / Challenge

Industrial IoT Use Cases

25B+ connected devices by 2020, many generating
a data package every millisecond

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> **Transportation / Aviation**
2.5PB of data per flight

> **Industrial Automation**
10 Billion samples per day

> **Energy (Oil & Gas, Metering)**
2-8TB of data per day

> **Asset Tracking / Supply Chain**
4 Billion data messages per day

> **IoT Storage Capacity**
87 exabytes shipped by 2021

NAND Flash Landscape
An arms race (that may not benefit Industrial IoT)

› **Big move to 3D with many transitions on horizon**
  - 64L → 96L → 128L
  - MLC → TLC → QLC

› **Primary focus on capacity, enterprise/client data**

› **TBW typically decreases**

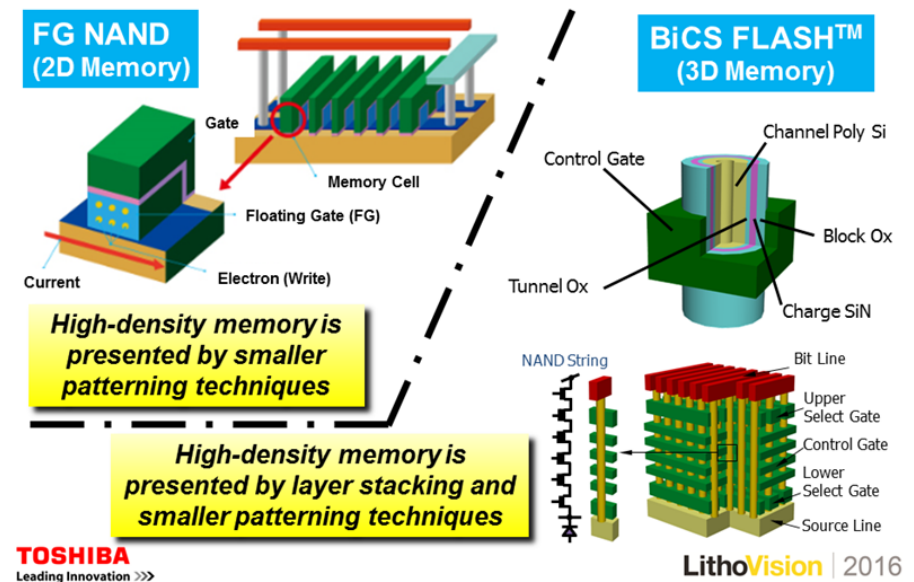› **Offerings short-lived**
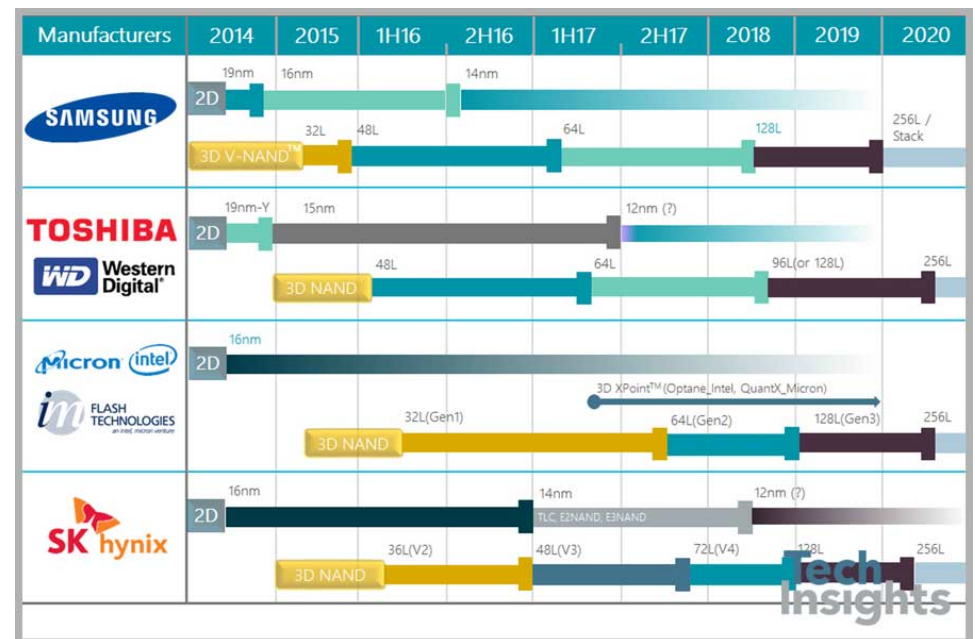
3D NAND Attributes
Improvements over 2D but with some challenges

> ### 3D NAND's charge trap has it's advantages

- Scalable to larger capacities
- Faster read/write operations
- Lower energy consumption

> ### But…some disadvantages

- Charge loss issues can result in lower data retention, especially at temperature
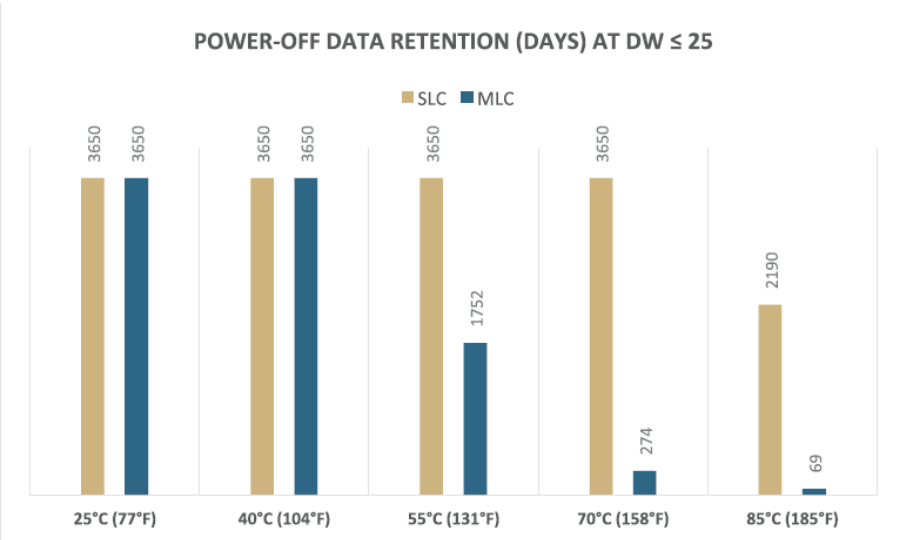

FG NAND (2D) vs BiCS FLASH™ (3D)

Visibility to workload and temp effects on data retention important

Data Retention & Temperature
A persistent problem getting worse?

➤ **2D MLC exhibits significant data retention loss at higher temps**

➤ **Will 3D TLC be better, same or worse?**

- Charge loss an inherent issue that increases with temp

- Can cause a large increase in RBER unless controller can shift read voltage to compensate for charge loss

POWER-OFF DATA RETENTION (DAYS) AT DW ≤ 25

■ SLC ■ MLC

Temperature	SLC	MLC
25°C (77°F)	3650	3650
40°C (104°F)	3650	3650
55°C (131°F)	3650	1752
70°C (158°F)	3650	274
85°C (185°F)	2190	69

***Visibility** to data retention critical for reliable SSD deployment*

Characteristics of Industrial IoT
Industrial IoT is different

› IoT workloads very demanding

› Capacity requirements lower

› Service life / availability 5+ years

› Subjected to extreme temps

› Monitoring & predicative maintenance provide high ROI

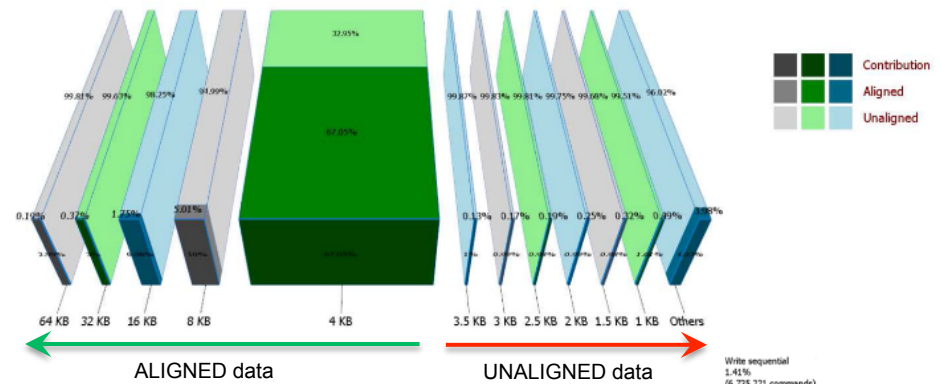**SSD selection is key!**

Industrial IoT Impact on Storage

Premature wear-out a concern, visibility key to addressing
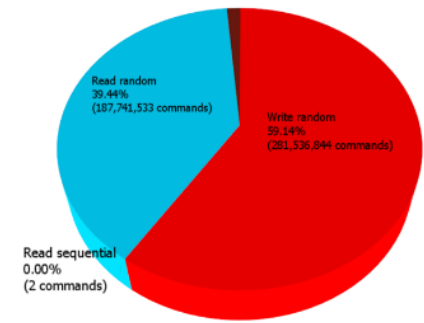

> ❯ IoT data is demanding

- Typically small-sector, random, and unaligned

- Coming 24/7/365, often milliseconds at a time

- Stored locally for years at a time, often at high temp

> ❯ Can drive write amplification up by factor of 8 (or more)

Monitor and Adapt

- Increase overprovisioning
- Block vs. Page mapping
- Data alignment
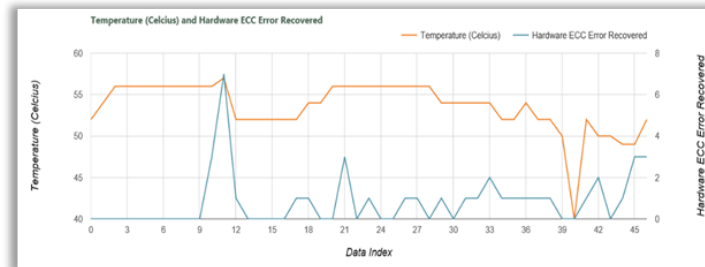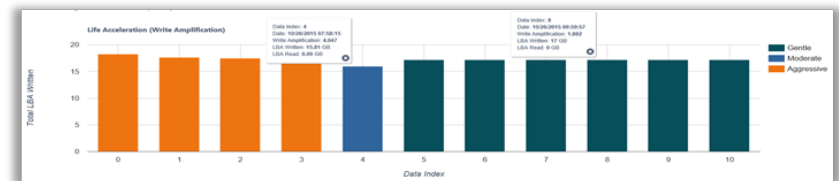- Use more durable NAND

Take Control

Industrial IoT Impact on Storage
Know your SSD

> ❯ Visibility to affects on SSD gives some control
>   - Adapting to workloads can increase endurance
>   - Optimizing software may be best overall solution
> ❯ If all else fails….
>   - Model application affects during qualification
>   - Predict when maintenance is needed

Visualize Usage

Temperature Characterization

Compare SSDs

SSD Monitoring & Management
## Common SSD attributes

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› Common SSD attributes worth monitoring

- Temperature (junction and ambient)

- Data Retention (how long, unpowered and at temperature)

- How changes in software / workload can affect endurance

› Tools should be easy to use for quick evaluation

- APIs for integration into existing software

- Open source for monitoring/mgt of any SSD

vtView Monitoring & Management
Good tools make for good decisions

Engineering
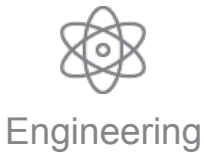
- Visualize workload and software impacts on endurance
- Visualize advanced features (TRIM) effects on endurance

Test Automation & System Regression

- Automate SSD testing and perform in-system regression analysis
- Compare effects of software / firmware changes to workload and endurance (don't be surprised)

Field Service
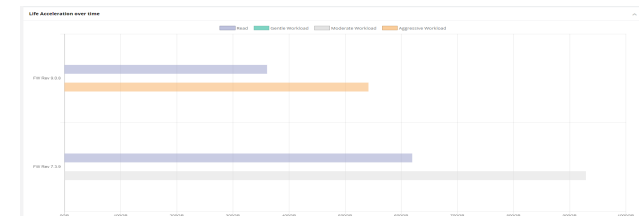
- Provide historical data for understanding of field usage (workload, temp, errors)
- Allows for quicker debugging and problem identification
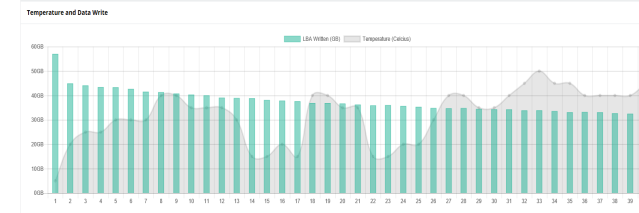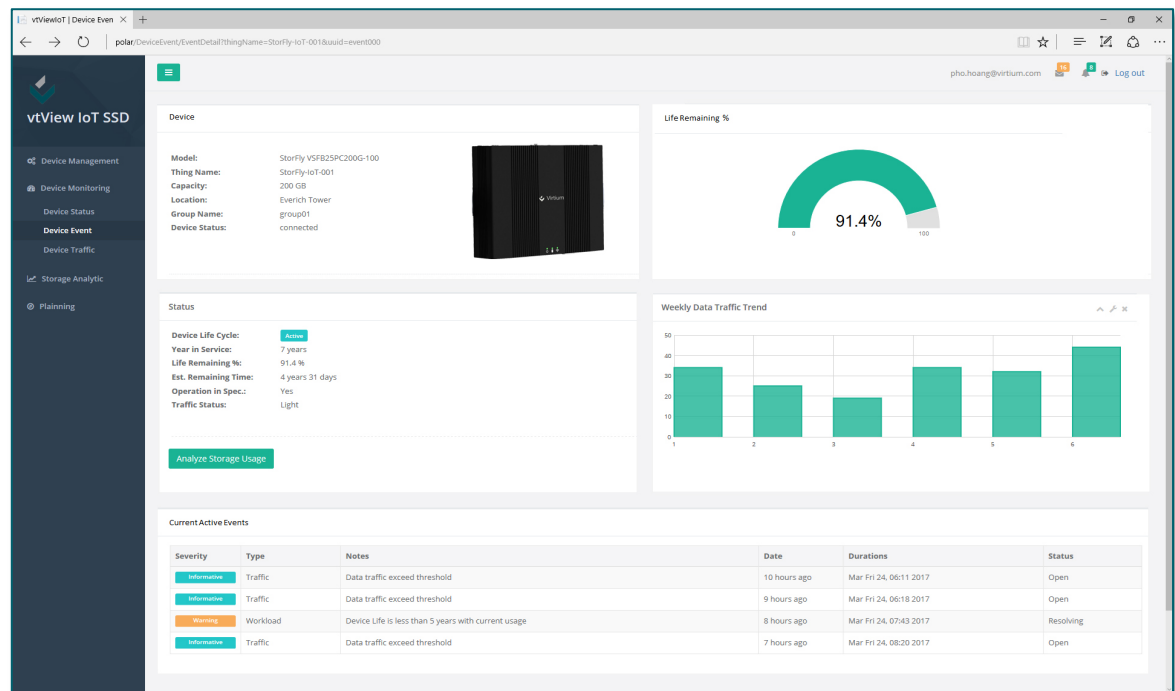
Storage Life Monitoring
Predictive Maintenance

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vtView

Analyze / predict storage life based on actual usage

Push notifications and firmware updates

Set **thresholds and alerts**

Conclusion

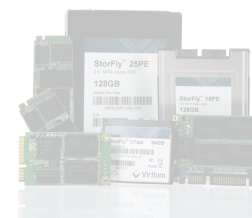Failing to plan is planning to fail

- › Reliance on datasheets and controller/FW is not enough

- › Know how your application affects storage

- › Model/Simulate app workloads to identify best storage solution at project outset

- › Select storage and software/ utilities that are flexible, scalable, and provide best TCO

Visualize / Monitor

Model / Simulate

Select & Manage

Thank You!