



Flash Memory Summit

Choosing the Right Flash Technology for Embedded & Industrial Applications

C.C. Wu, VP Embedded Flash Division



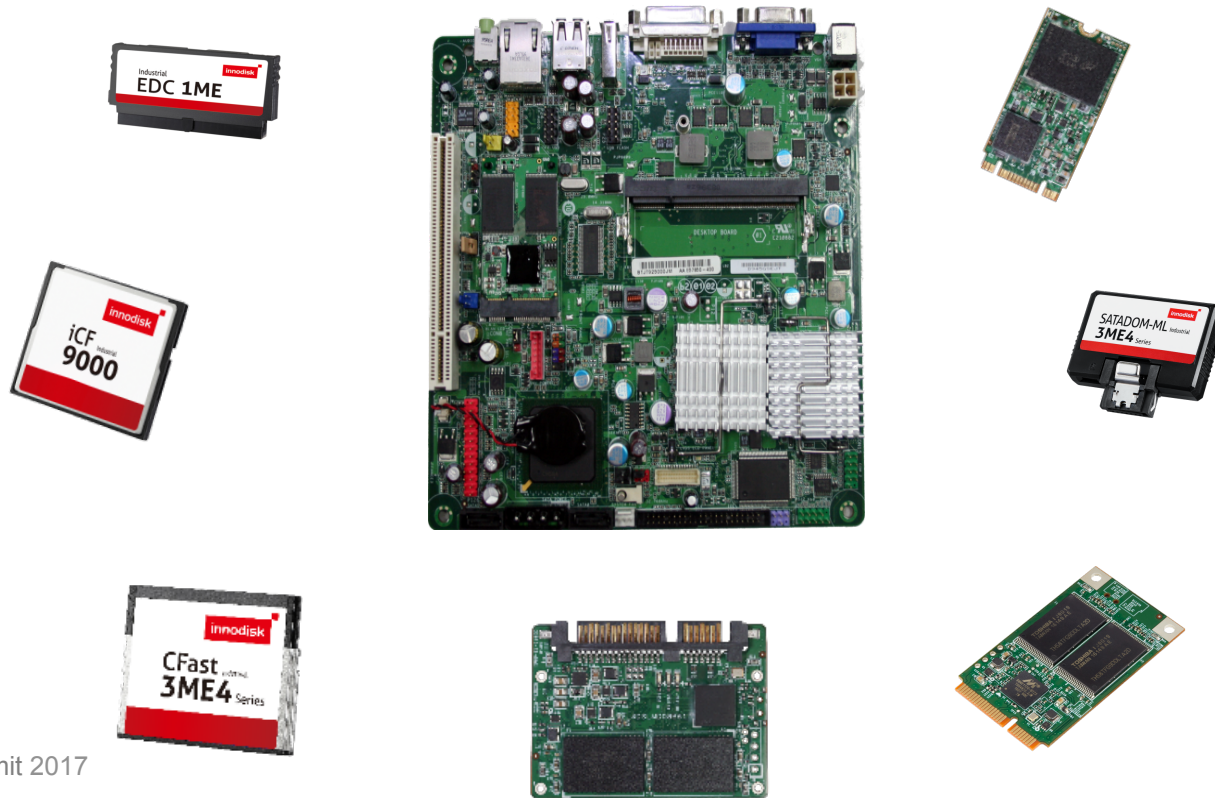
Flash Memory Summit 2017
Santa Clara, CA



Agenda

- Current outlook of Embedded Solutions
- Challenge we face
- Impact of 3D NAND in embedded applications
- NVMe SSD in embedded applications
- New SMART idea
- Summary

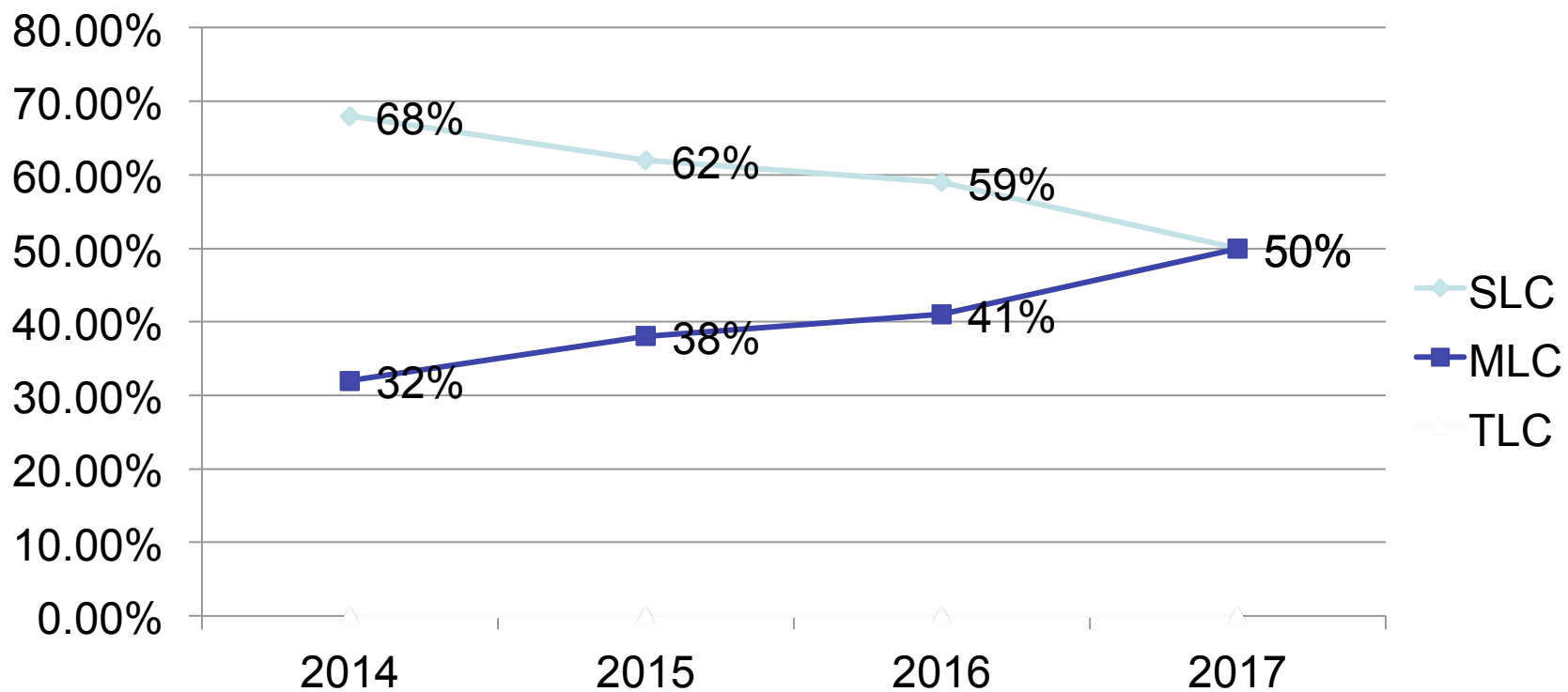
Popular Form Factor for Embedded





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Flash Demand in Embedded Market



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Source by innodisk



Flash Comparison

Item	SLC Single Level Cell	iSLC Inno SLC mode	MLC Multi Level Cell
Architecture	<p>SLC Flash has only two states: erased (empty) or programmed (full).</p> <p>SLC One bit per cell</p>	<p>Enhance iSLC, algorithm & Enhance ECC</p> <p>MLC iSLC</p>	<p>MLC Flash has four states: erased (empty), 1/3, 2/3, and programmed (full).</p> <p>MLC Two bits per cell</p>
Performance	Best	Faster	Slower
Power Consumption	Lowest	Lower	Higher
Endurance (P/E Cycles)	60K	20K	3K
Initial Data Retention	10 Years	10 Years	10 Years
Density	MLC > iSLC > SLC		
Cost			
Application	<p>1. IPC </p> <p>2. Mission-critical applications</p>	<p>1. IPC/Kiosk/ </p> <p>2. Embedded System</p> <p>3. Server MB</p> <p>4. Write intended application.</p>	<p>1. POS, Kiosk system </p> <p>2. Commercial application</p>

← 7 times



Current Outlook of Embedded Solution

- 2x nm SLC under 16GB remains popular for embedded market
- 15/16 nm MLC is a major player for embedded applications
- iSLC remains a strong solution for high endurance applications and more economical than SLC
- TLC is not used in embedded market



Challenge We Face

- Lifespan of MLC in Block Mode FTL
- Implementing 4K mapping FTL to solve lifespan issue, created issues in sustaining write performance (*TRIM can improve write performance*)
- Data retention issues
 - Some read only applications are facing data retention issues
 - MLC is weak in high temperature and high PE cycle

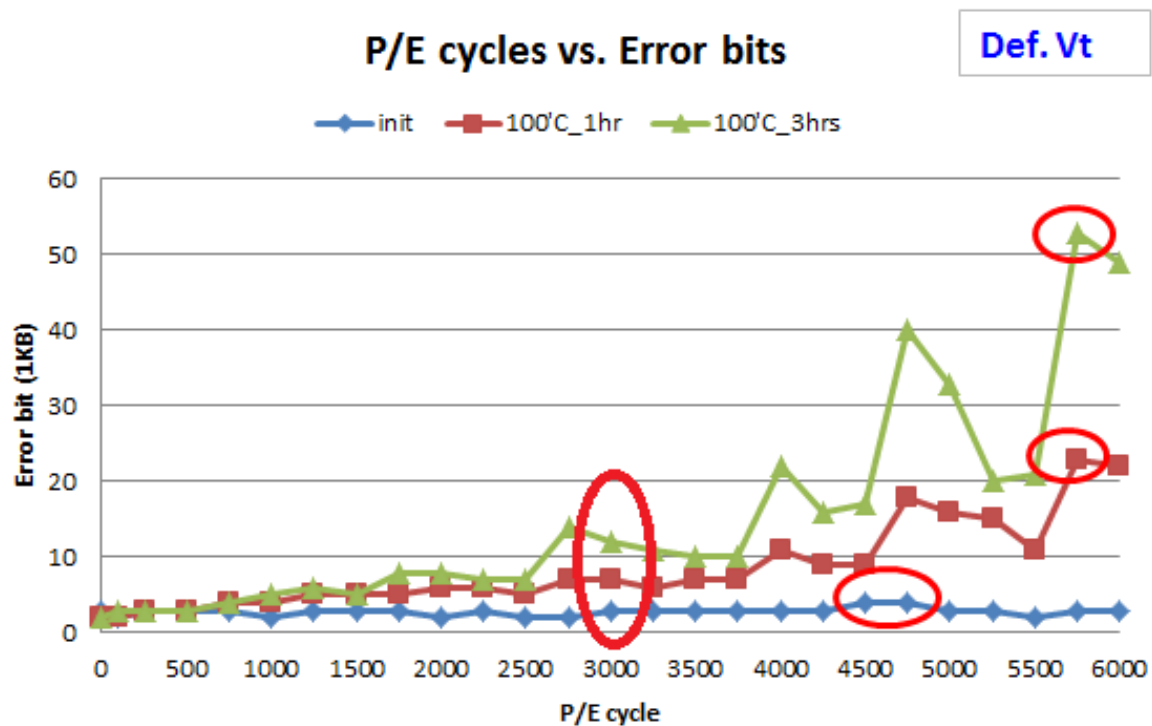


Challenge We Face

- SATA 32 NCQ commands support
 - Each command with 32KB data
 - This will take more than 20 seconds in heaving loading

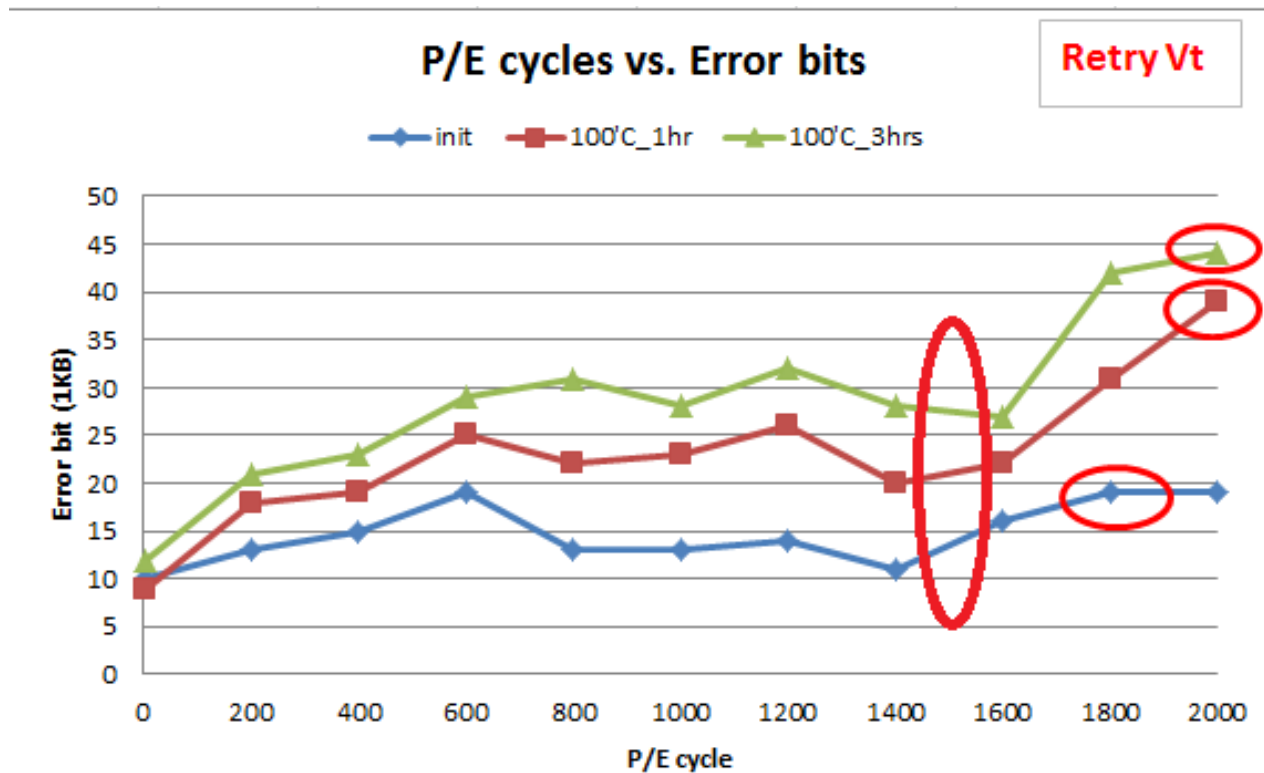
3D MLC Quality

3D MLC pass
3K PE cycle



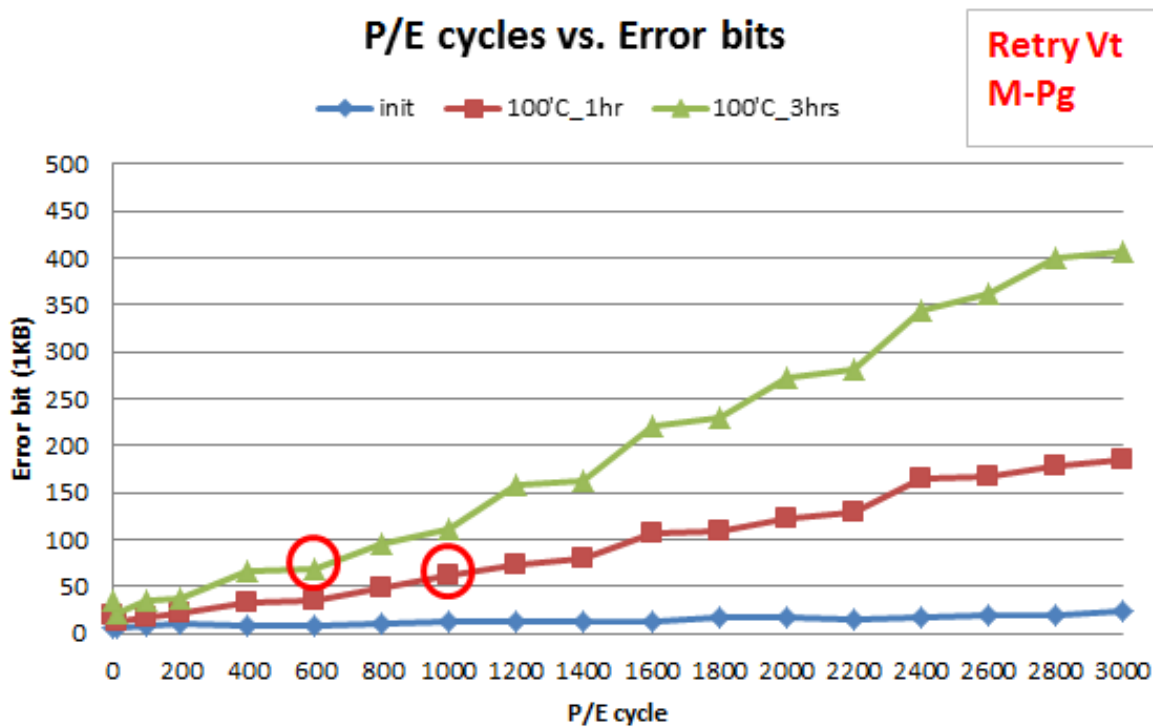
3D TLC Quality (A Company)

3D TLC pass
1.5K PE cycle



3D TLC Quality (B Company)

3D TLC still has poor data retention quality

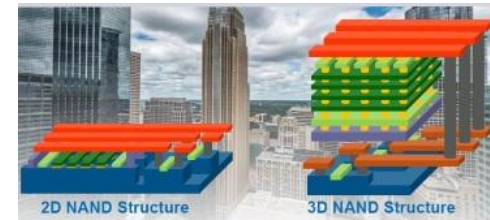




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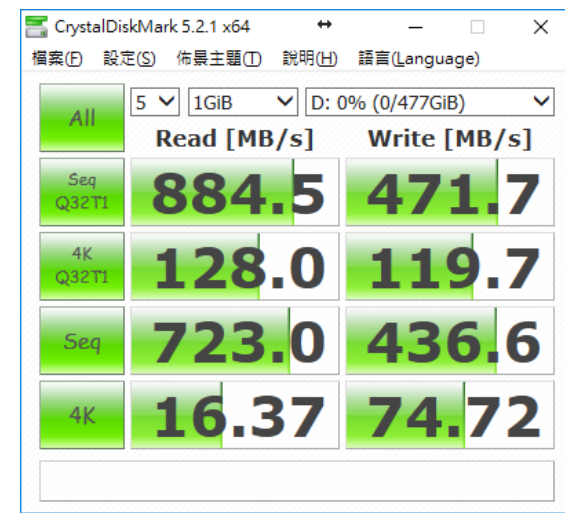
Impact of 3D NAND in embedded applications

- 3D MLC 3K PE Cycle
- 3D TLC 1.5K PE Cycle...Is it enough?
- Last Page Program Failure
 - Data lost for few pages
 - PLP design or power lost protection algorithm is important
- 3D TLC data retention remains an issue
 - It is better to have a algorithm to recover it



NVMe SSD in embedded application

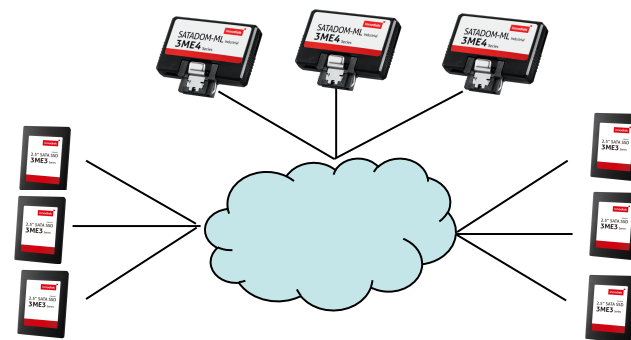
- Boot up solution for OS
- PCIe Gen 3 x 2
- NVMe1.2b
- None DRAM Solution
- 3D TLC
- Performance: Target 1.2GB/s Read, 800MB/s Write



	Read [MB/s]	Write [MB/s]	
All	5	1GiB	D: 0% (0/477GiB)
Seq Q32T1	884.5	471.7	
4K Q32T1	128.0	119.7	
Seq	723.0	436.6	
4K	16.37	74.72	

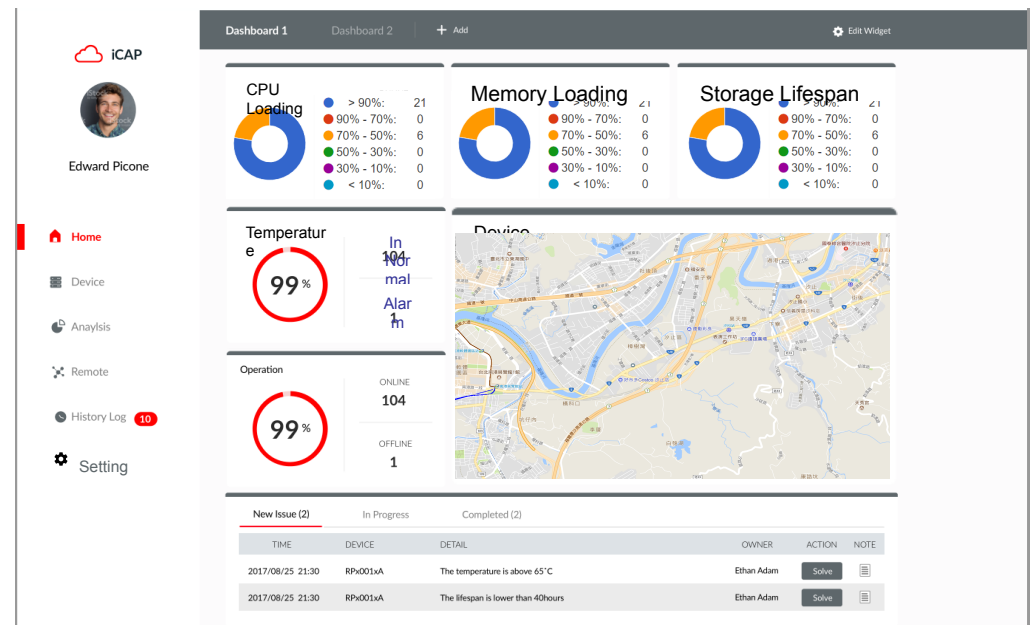
How to monitor thousands of SSD?

- Limitation of lifespan
- Replace SSD before its down
- What tool can easily monitor SSDs?

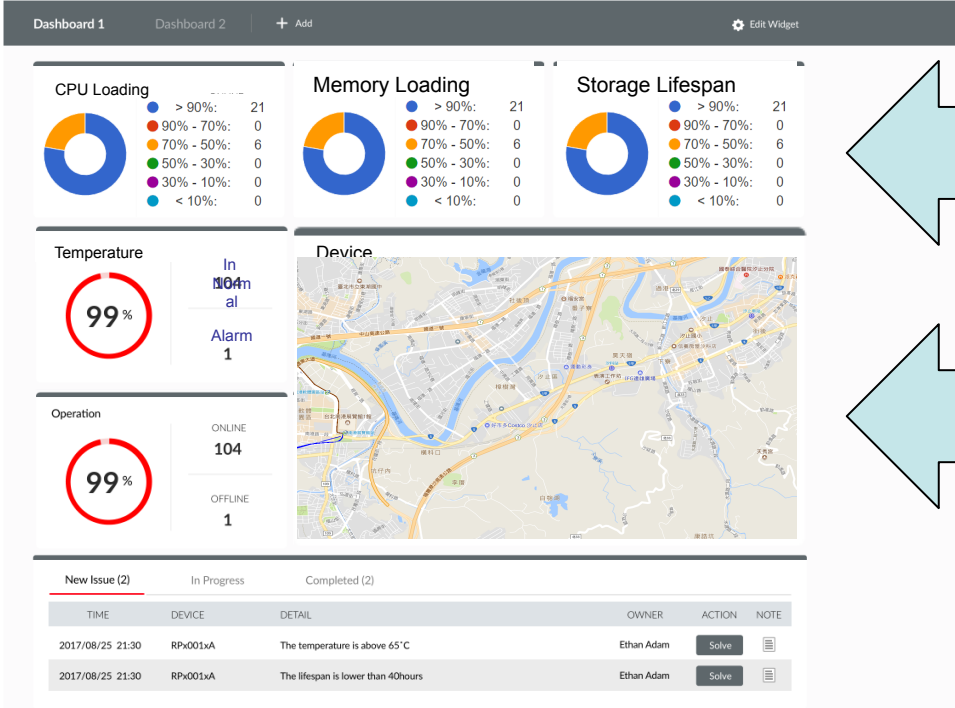


iCAP for SMART

- Cloud version of iSMART
- You can monitor thousands of SSDs in office
- You can implement on a private or public cloud



iCAP Program



The dashboard displays the following widgets:

- CPU Loading:** Donut chart showing 21 instances with loading > 90%.
- Memory Loading:** Donut chart showing 21 instances with loading > 90%.
- Storage Lifespan:** Donut chart showing 21 instances with lifespan > 90%.
- Temperature:** Gauge showing 99% with an 'In Alarm' indicator and 'Alarm 1'.
- Operation:** Gauge showing 99% with 'ONLINE 104' and 'OFFLINE 1'.
- Device:** Map showing the location of the device.

Issues table:

TIME	DEVICE	DETAIL	OWNER	ACTION	NOTE
2017/08/25 21:30	RPx001xA	The temperature is above 65°C	Ethan Adam	Solve	
2017/08/25 21:30	RPx001xA	The lifespan is lower than 40hours	Ethan Adam	Solve	

← Lifespan

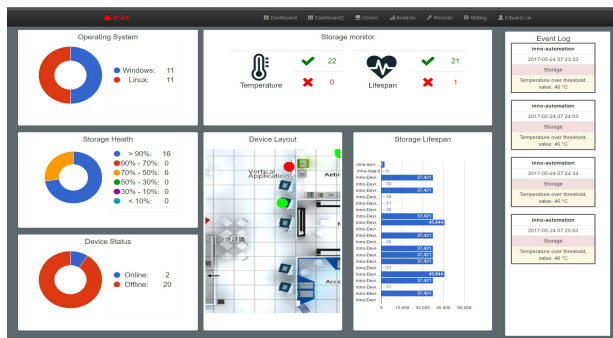
← Location



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Features of iCAP

Web-Based Management



- **Dashboard**
 - Information statistics
 - Device location
 - Event logging
- **Device information**
 - OS /device status / alert
- **Analysis**
 - SSD R/W behavior
- **Remote Control**
 - System recovery & backup
 - DIO management



Summary



- 2D MLC is the best flash chip for the embedded market
- 3D MLC's quality is good for embedded
- 3D TLC's quality remains a challenge
- SATA interface is still main stream for embedded boot up storage
- NVMe has been introduced into this market



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