



# Industry Innovation with Samsung's Next Generation V-NAND

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Flash Memory  
Summit 2014  
Santa Clara, CA

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# Overview

## 1. Industry Trends



## 2. 3D V-NAND



## 3. NVMe SSD



## 4. New Solutions



# Overview

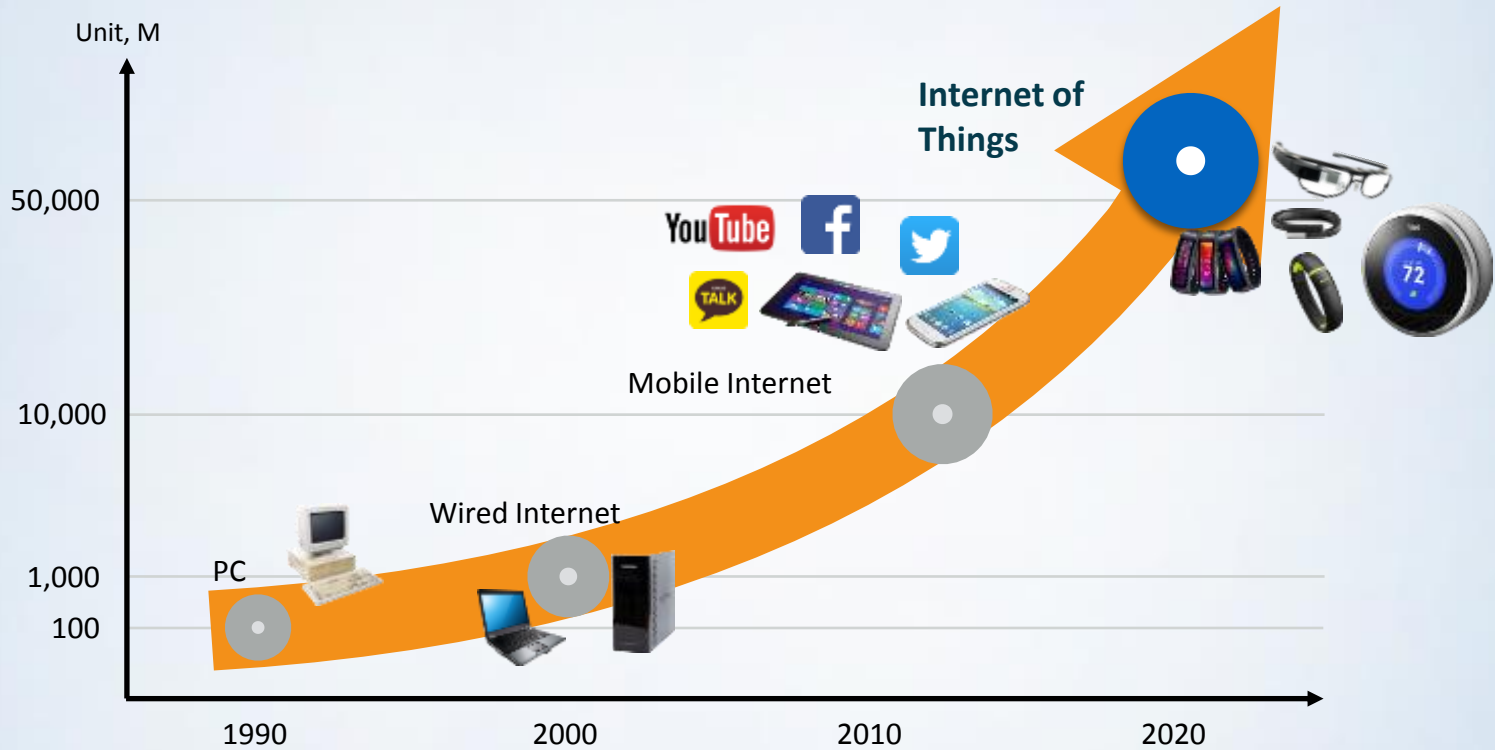
## 1. Industry Trends



The background is a vibrant blue gradient with a digital theme. It features a network of glowing white lines and nodes, suggesting data flow or connectivity. Overlaid on this are vertical columns of binary code (0s and 1s) in a lighter blue color, creating a sense of depth and data volume. The overall aesthetic is futuristic and high-tech.

# Data Explosion Era

# IT Growth Drivers: PC → Mobile → IoT



Source: KPCB, Cisco

50 Billion Devices by 2020



# Mobile Data Traffic Growth

2018:  
Billions of Devices  
190EB



More Connections



Faster Speeds



More Users

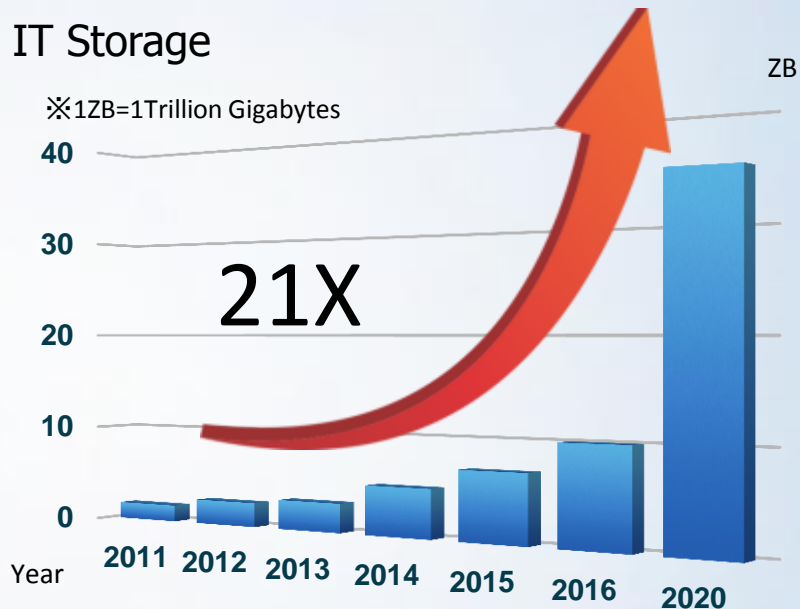
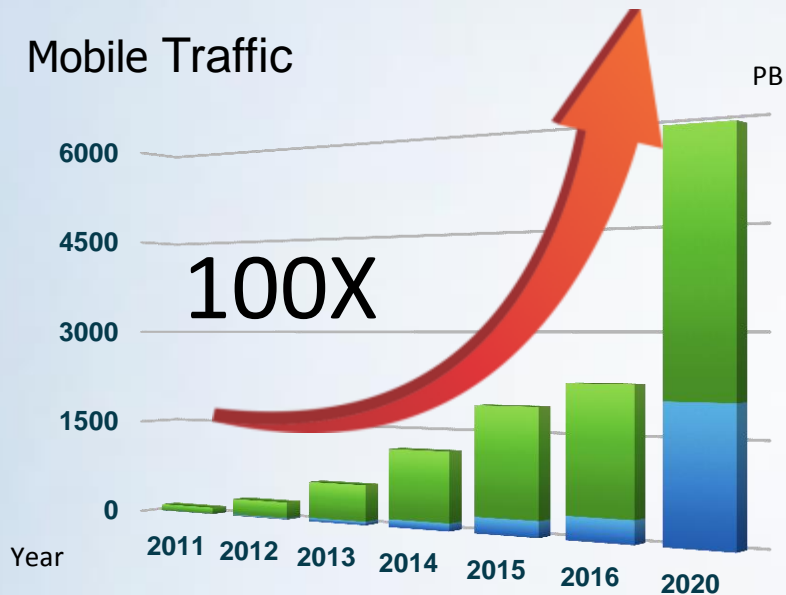


More Video

**5EB** The total data created between the dawn of civilization and 2003



# Mobile Era - Data Explosion



More video is uploaded to YouTube in one month than the 3 major US networks created in 60 years

Source: Samsung





# Social Networking Changing Everything

Facebook



>8.7B Pages / day

WhatsApp



>50B Messages / day

Twitter



>500M Tweets / day

SnapChat



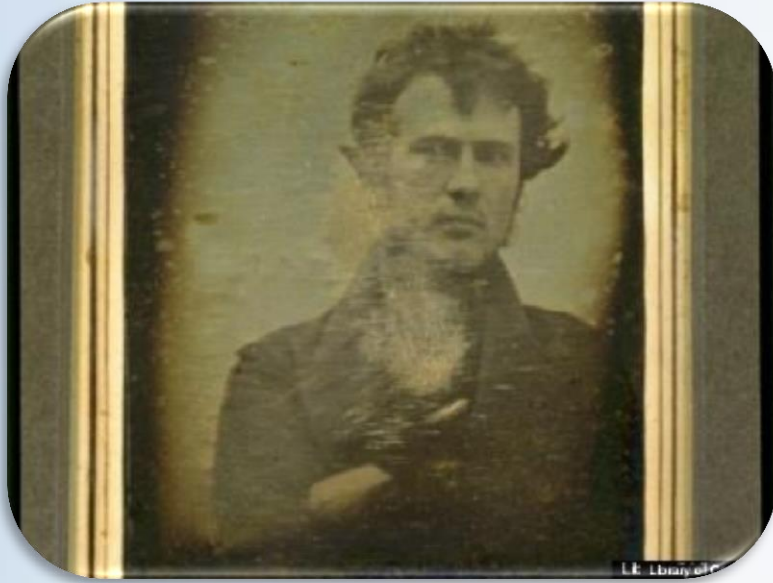
>1.2B Messages / day

Phones Checked 100B Times / Day

✘ Source: Google

SAMSUNG

# Social Networking: Then and Now...



First Selfie (1839)



Pope Francis (2013)

100M+ "Selfies" Taken / Day

※ Source: Google



# Space: Then and Now



1969



2012

# Viral Selfies in the News...

March 2, 2014



During the 86th Academy Awards  
Ellen DeGeneres' Selfie shuts down Twitter



The Selfie that shut down Twitter with a record  
1.2 million retweets in 15 minutes...

# What Selfie Will Break the Record?



Jim Elliott @Jimelliott70 · Aug 1

Great view of the new 49er stadium from the roof of our new building. Can't wait for the ribbon cutting in mid-2015!



[View more photos and videos](#)



# The New World Record



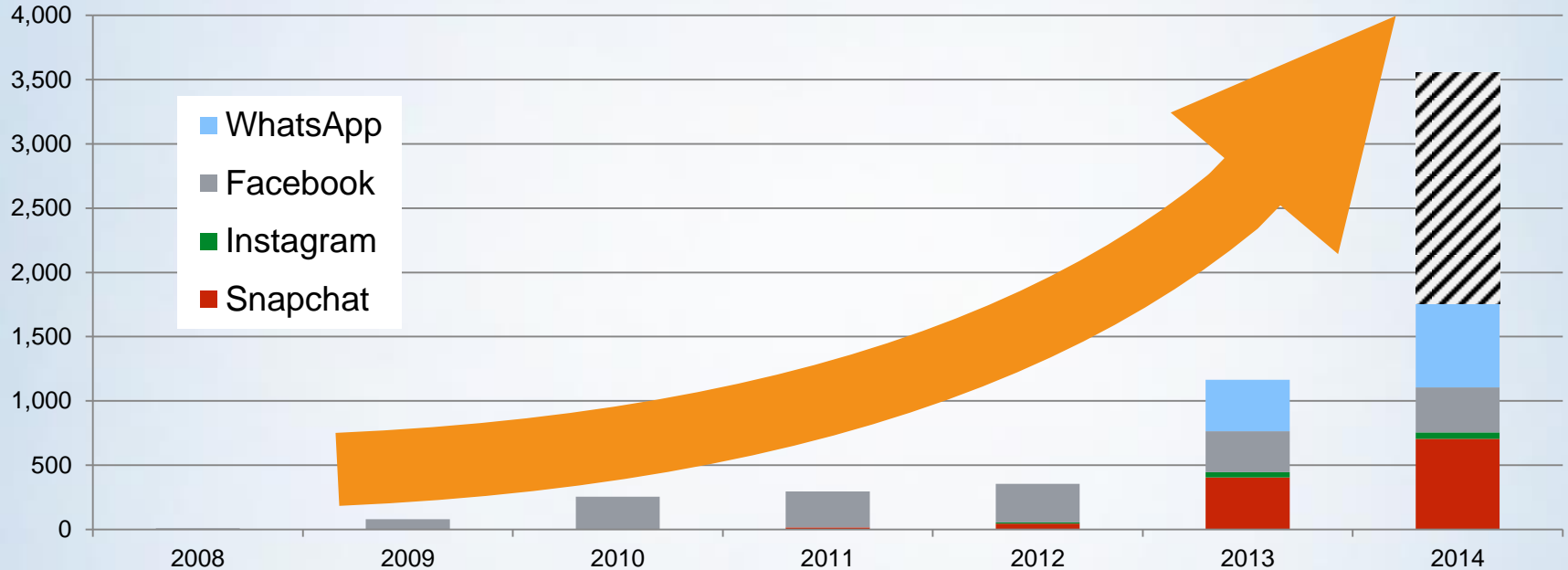
FIFA WORLD CUP  
BRASIL

“Winning” Selfie Creates New Record:  
>32M Re-Tweets



# Exponential Growth: 3.6B Photos / Day in 2014

## Daily Photo Uploads



※ 2014 YTD as of May. FCST is extrapolation of public data.

91% of Mobile Internet Access is for Social Media





New Era for Flash



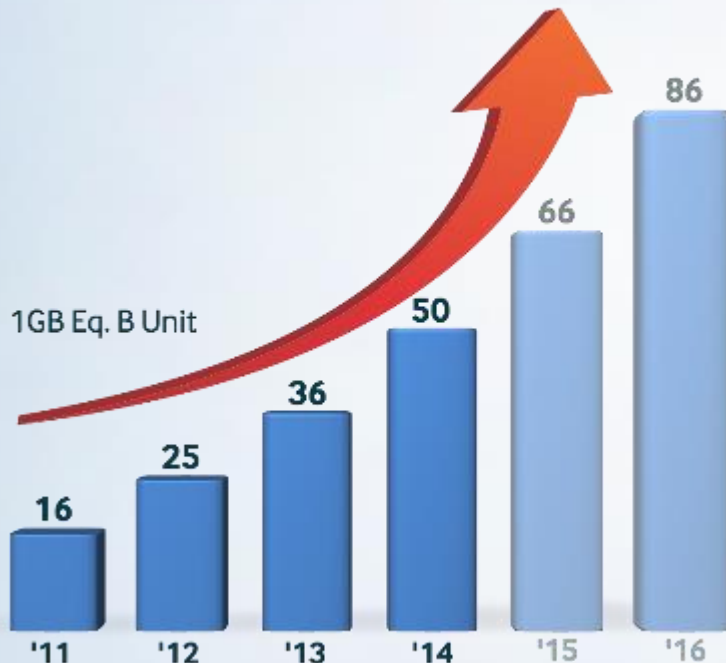
# NAND Flash Ubiquity

*NAND at the core of the data center  
and every consumer device*

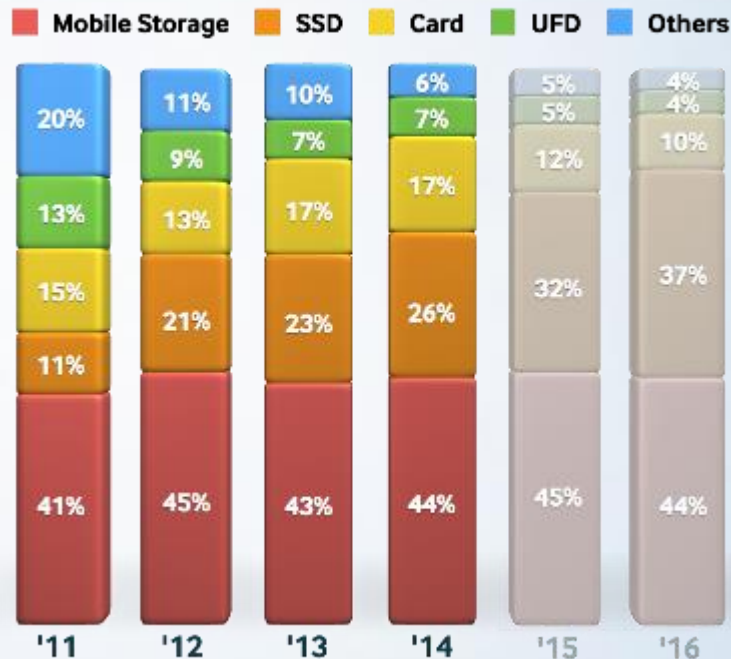


# NAND Growth Outlook

## NAND Demand Growth (Bit)



## Portion Change by Application



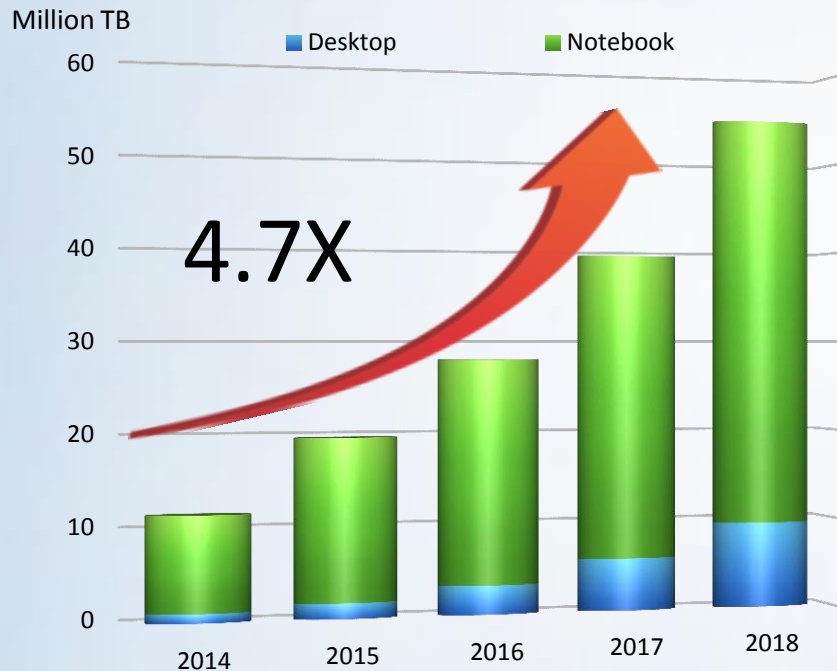
\*Source: Samsung

Exponential Growth Continues

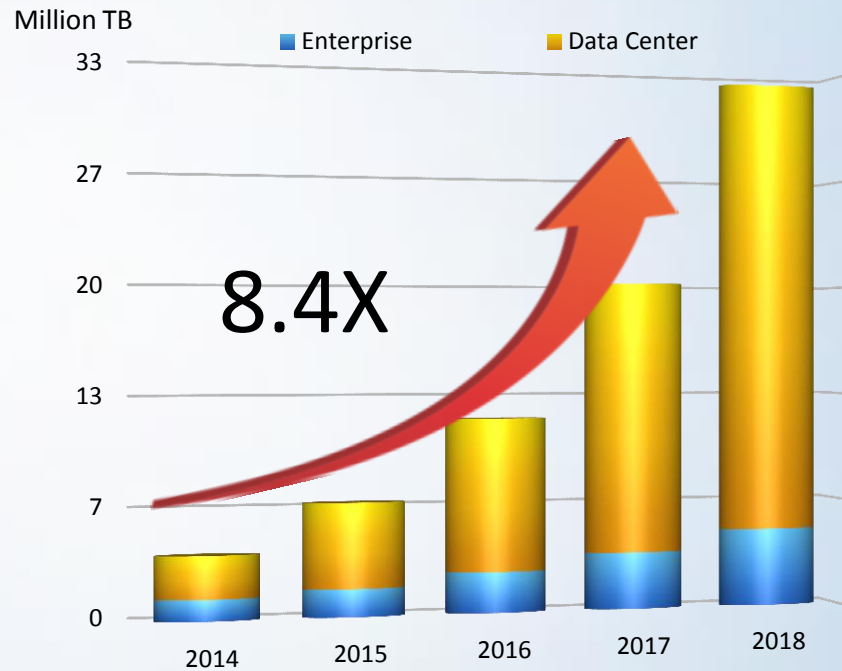


# SSD Growth Outlook

## PC Market



## Data Center / Enterprise Market



iSuppli, 'Q1 2014 + Samsung MKT, 'Q1 2014

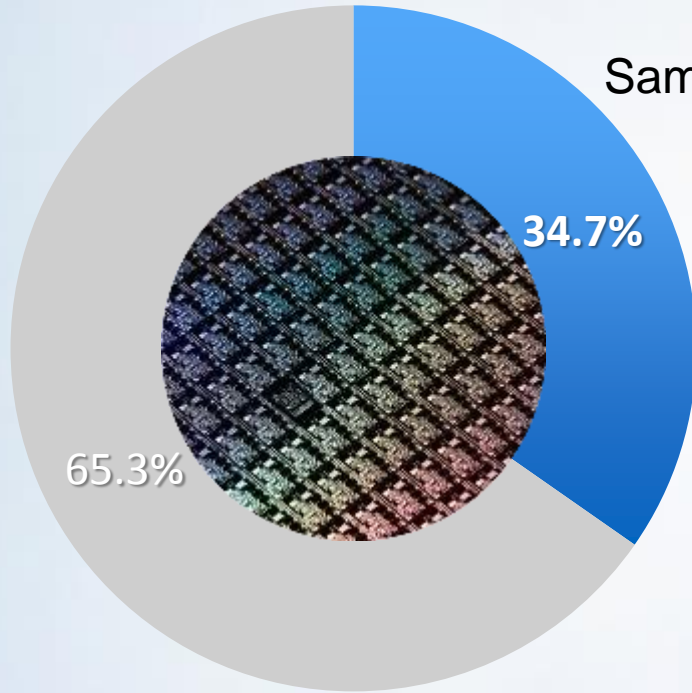
Exponential Growth Continues



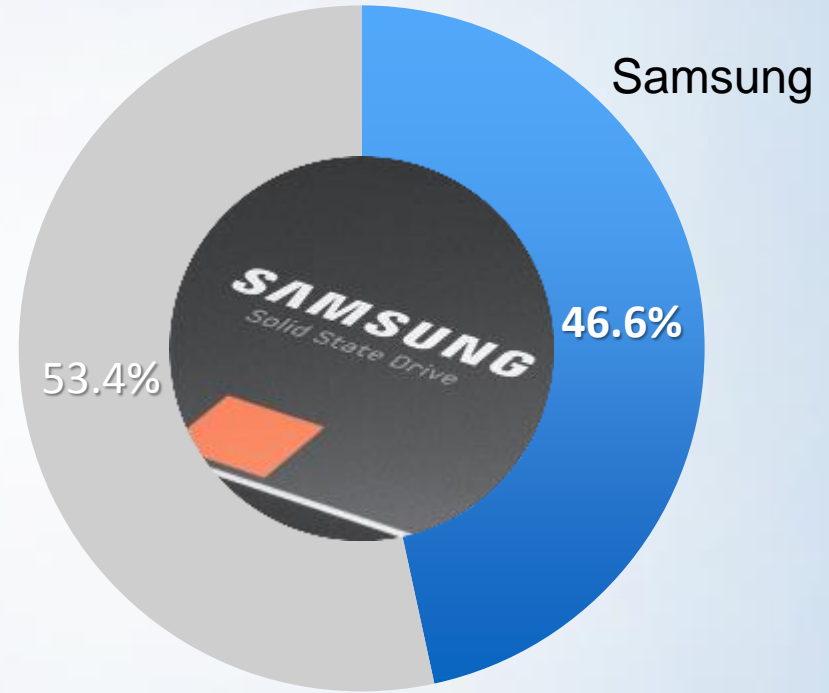
# **Samsung NAND Leadership**



# Samsung Memory Market Share Leadership



NAND



SSD

\*Source: Samsung 2013



# 2006: Launched our First SSD



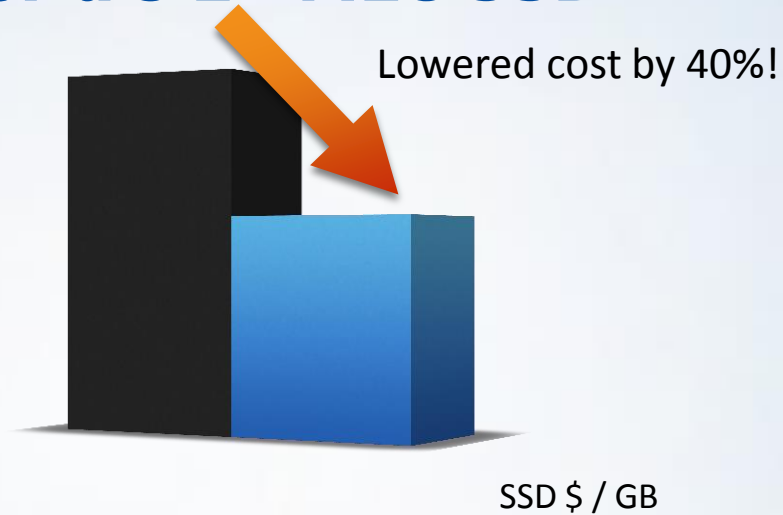
Brought SSD's to the mainstream market

2006

1<sup>st</sup> Samsung  
SSD

SAMSUNG

# 2008: World's 1<sup>st</sup> MLC SSD



Reduced Cost and Higher Density for wide spread adoption



2006

1<sup>st</sup> Samsung  
SSD

2008

1<sup>st</sup> 2bit MLC  
SSD

# 2012: World's 1<sup>st</sup> 3bit SSD



Higher capacity to compete with HDD



2006

1<sup>st</sup> Samsung  
SSD

2008

1<sup>st</sup> 2bit MLC  
SSD

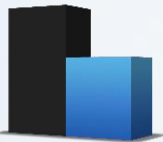
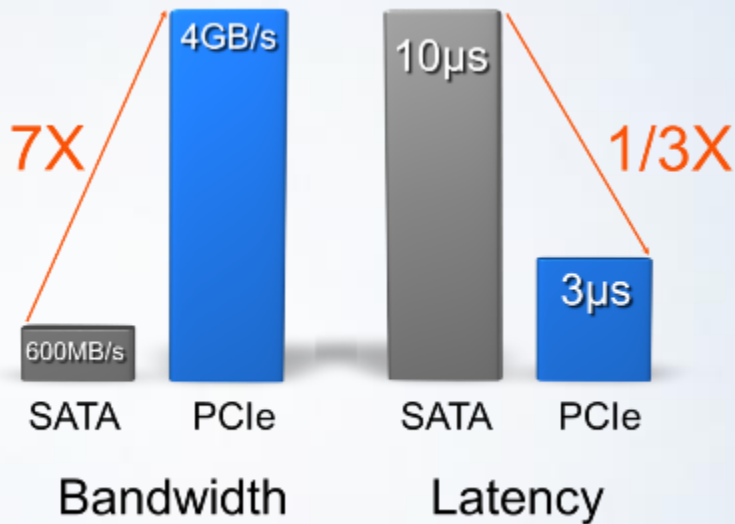
2012

1<sup>st</sup> 3bit  
SSD





# 2013: World's 1<sup>st</sup> PCIe SSD for PC



2006

1<sup>st</sup> Samsung  
SSD

2008

1<sup>st</sup> 2bit MLC  
SSD

2012

1<sup>st</sup> 3bit  
SSD

2013

1<sup>st</sup> PCIe PC  
SSD

# 2013: World's 1<sup>st</sup> 3D V-NAND SSD

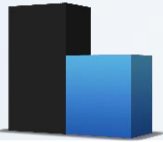


More Capacity  
More Speed  
More Power Efficiency



2006

1<sup>st</sup> Samsung  
SSD



2008

1<sup>st</sup> 2bit MLC  
SSD



2012

1<sup>st</sup> 3bit  
SSD



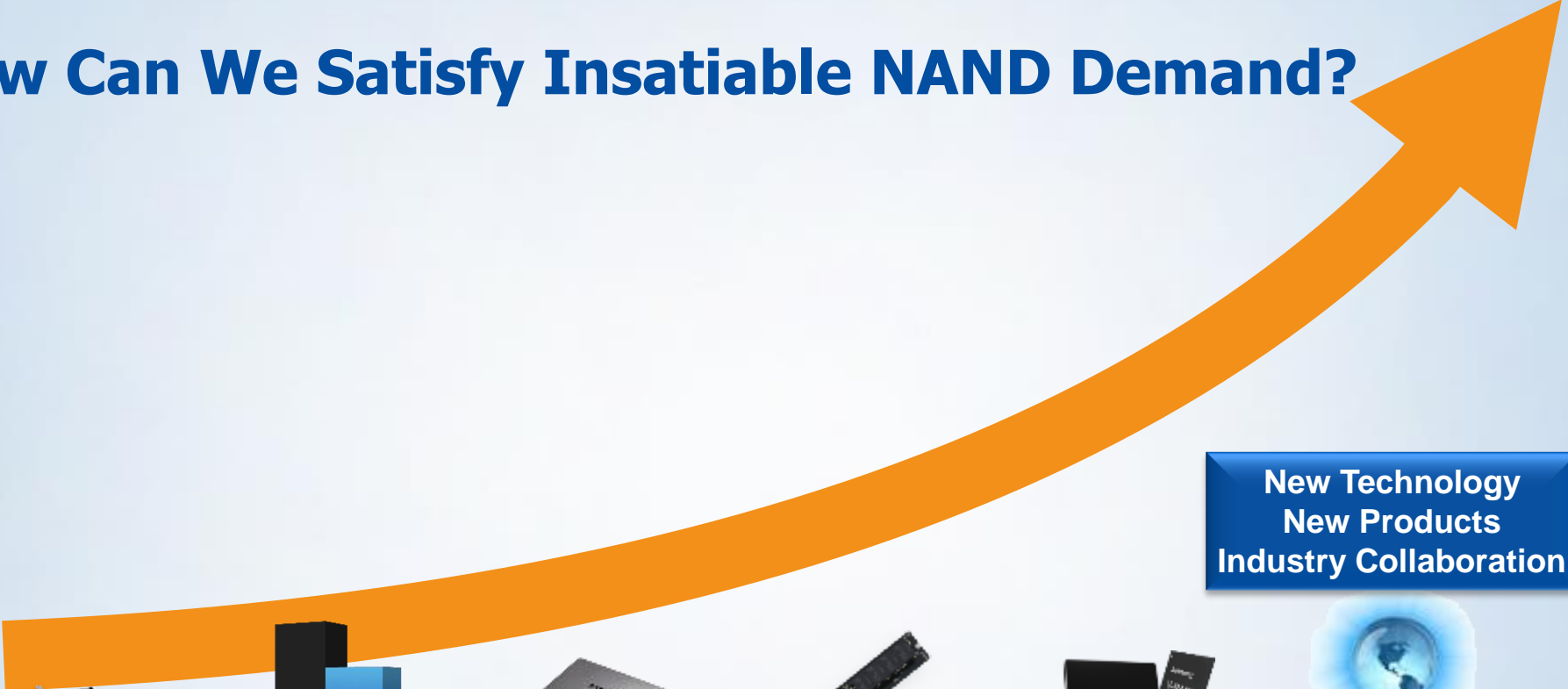
2013

1<sup>st</sup> PCIe PC  
SSD

2013

1<sup>st</sup> 3D  
V-NAND SSD

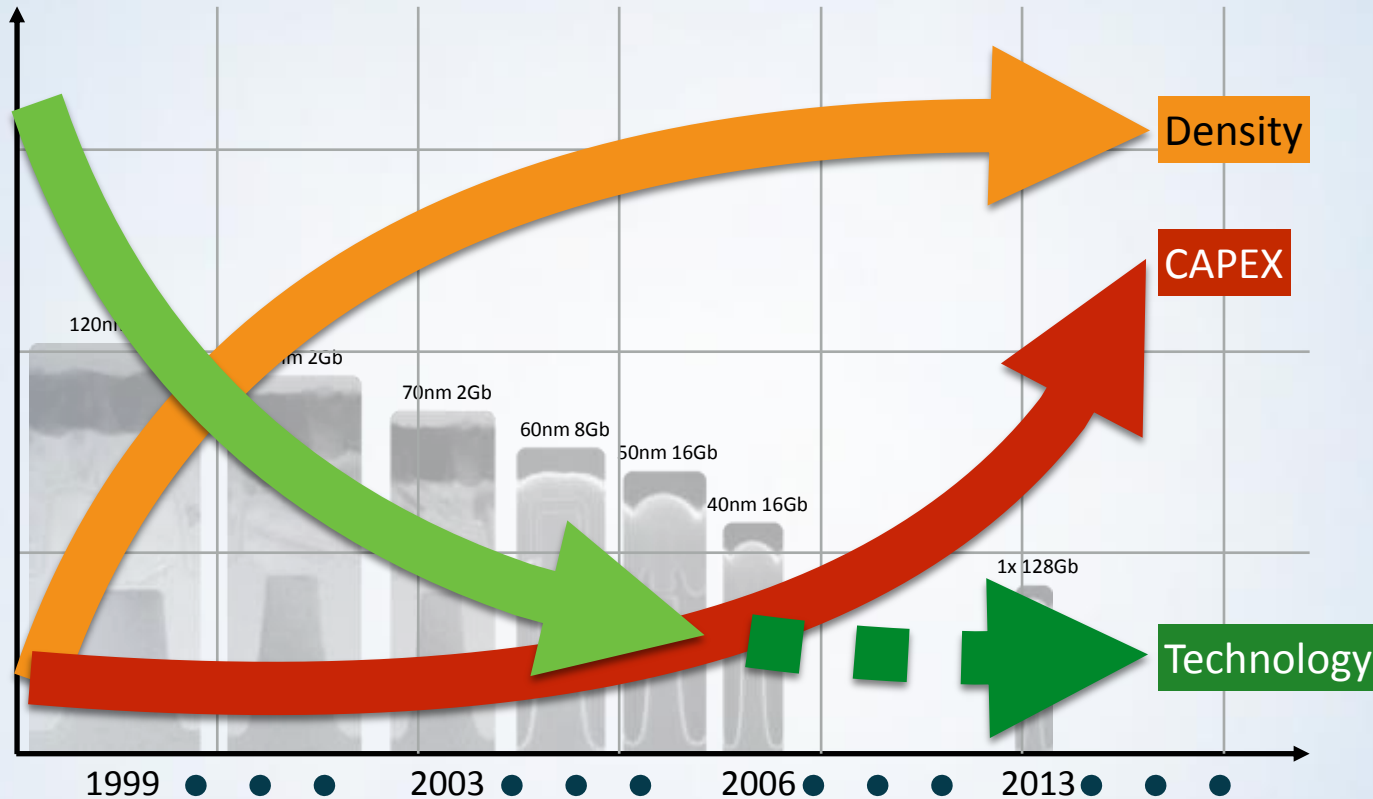
# How Can We Satisfy Insatiable NAND Demand?



New Technology  
New Products  
Industry Collaboration

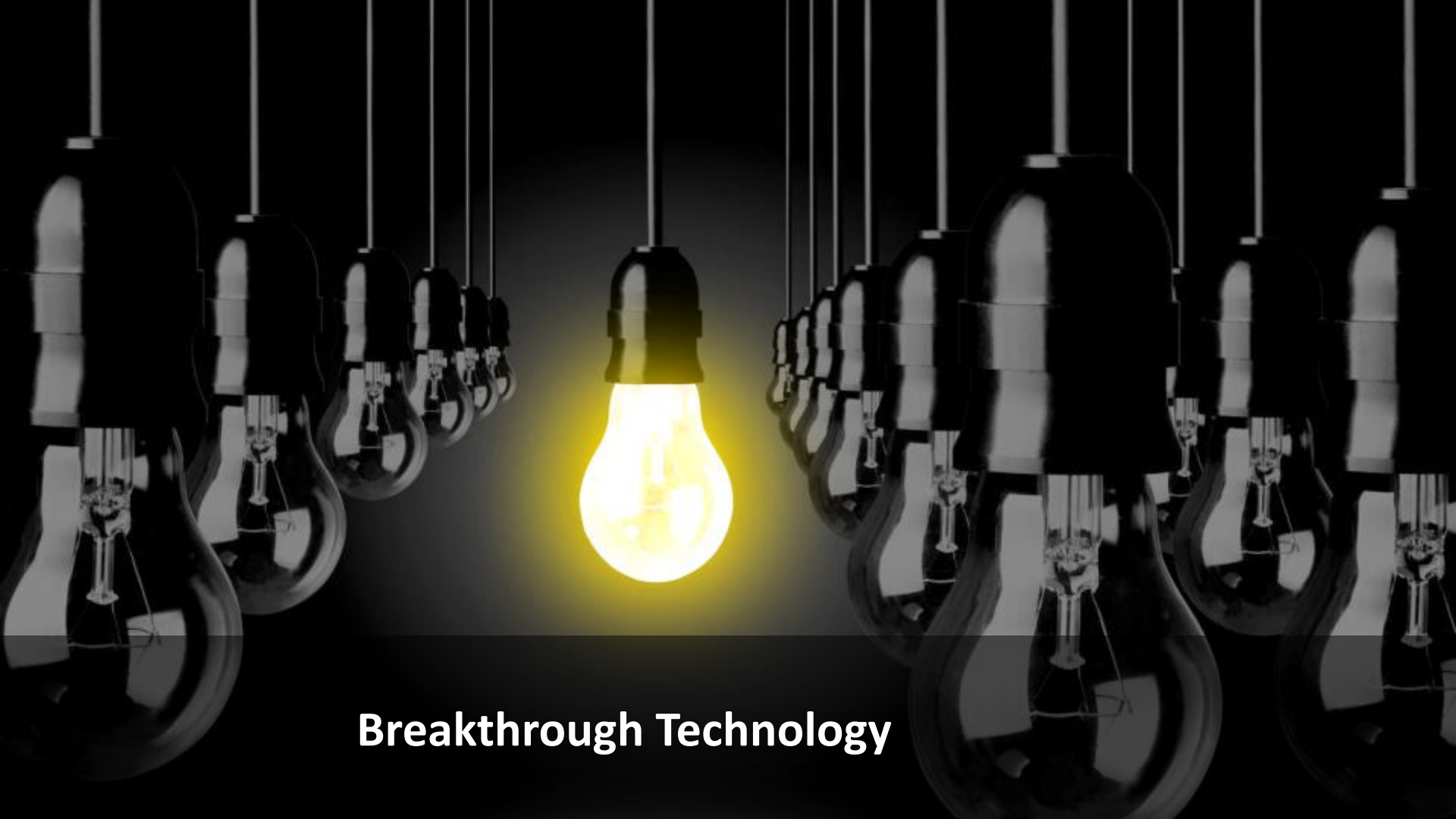


# NAND Flash Challenges



We Need a Breakthrough...





**Breakthrough Technology**



3D V-NAND





**Bob Brennan**

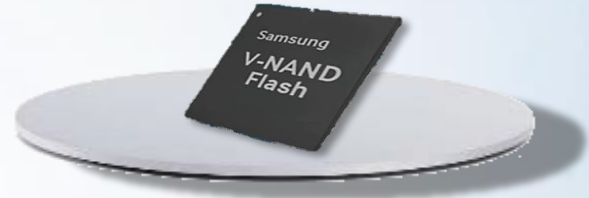
(SVP, Memory Solutions Lab)

# Overview

## 1. Industry Trends



## 2. 3D V-NAND





# 2013: World's 1<sup>st</sup> 3D V-NAND

128Gb : **24** Stack **2bit**



AUGUST 14TH, 2013 by Josh Shaman

## Samsung 3D V-NAND SSD Announced

Samsung mass produces industry's first 3D NAND flash chips

August 5, 2013 07:08 PM ET

The 3D flash technology lays a foundation for next generation 1Tbit chips



**Broke Through 10nm Process Barrier**

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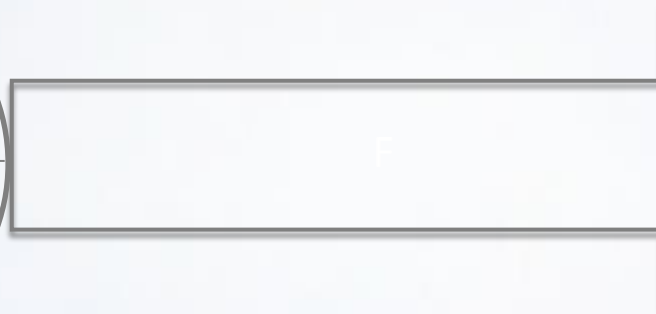
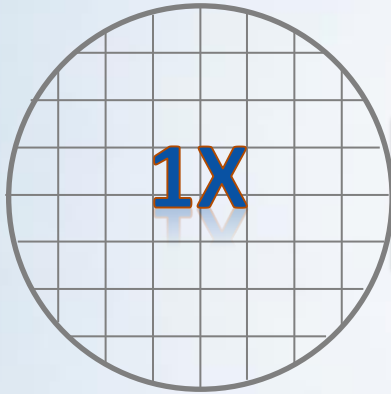
# 2014: 2<sup>nd</sup> Generation



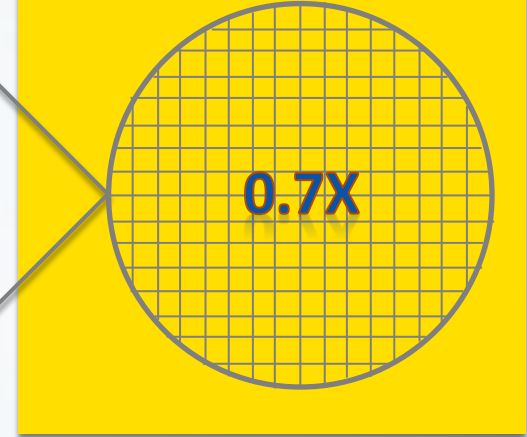
# 2<sup>nd</sup> Generation 3D V-NAND

128Gb **32 Stack 2bit** cell

24 Stack 2bit



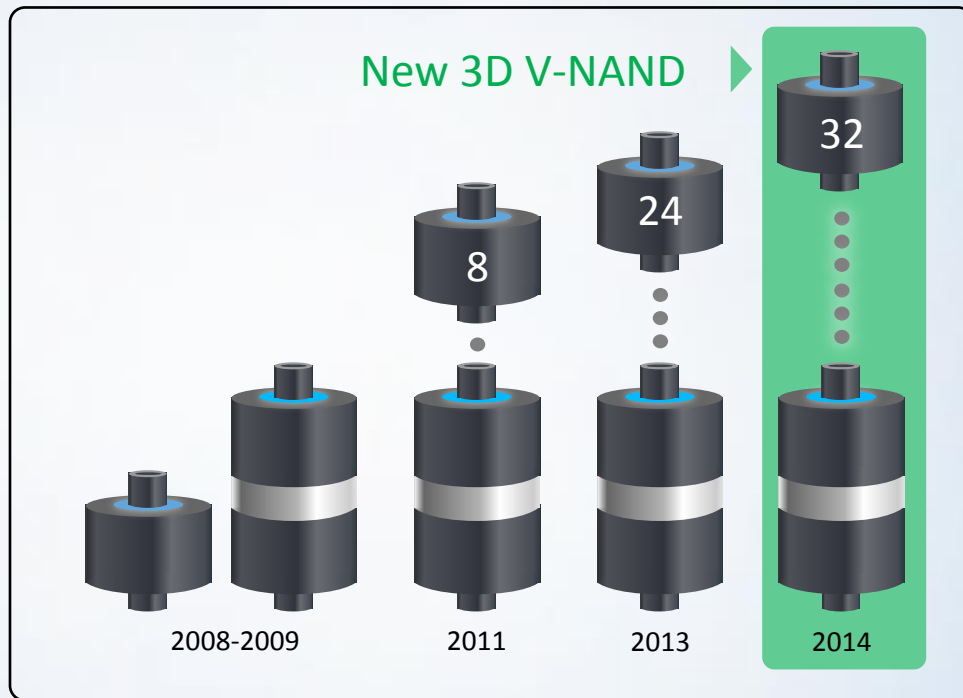
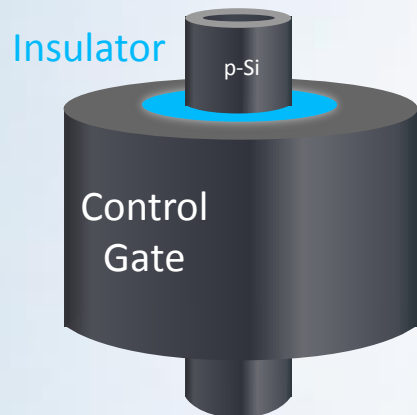
**32 Stack 2bit**



**1.4X Density**



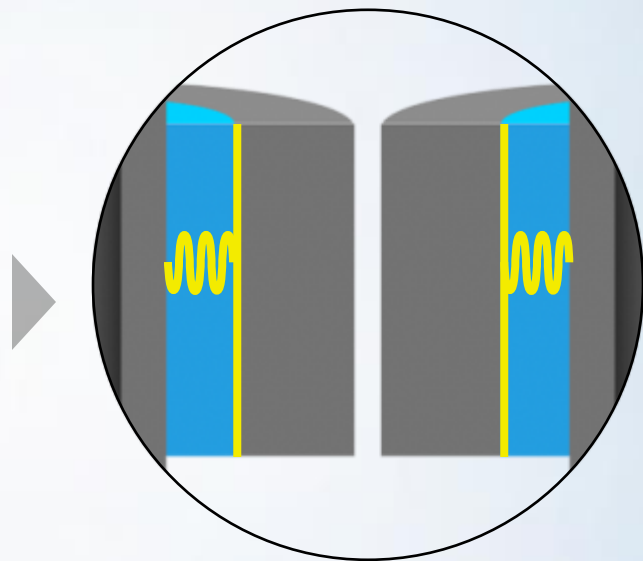
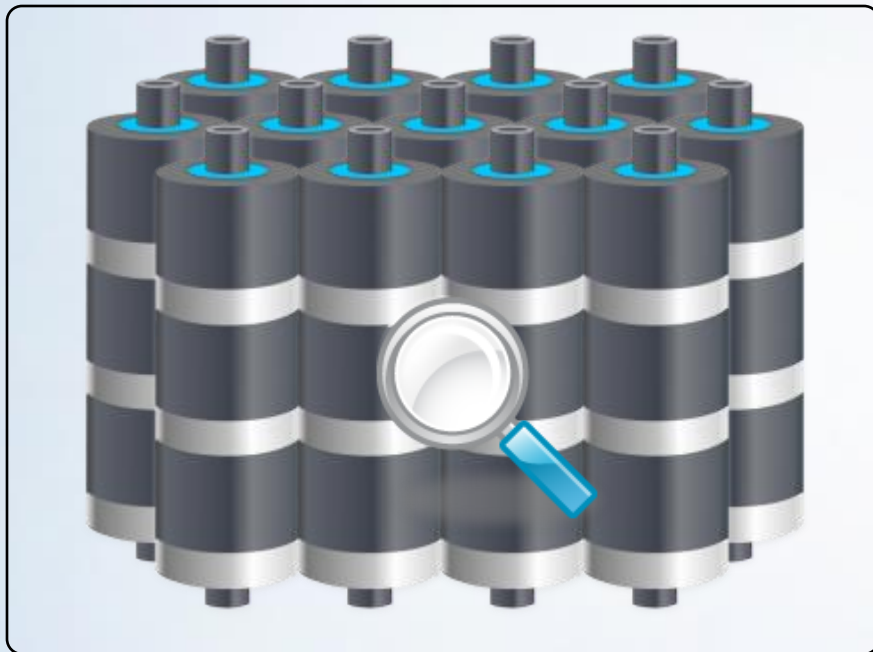
# Integration Innovation



Scaling Continues



# Cell to Cell Interference-Free Structure



32 Stack = 24 Stack



24 → 32 Stack V-NAND Maintains Low Interference

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# 2014: 850 PRO : World's 1<sup>st</sup> 32 Stack V-NAND SSD



'3D V-NAND created the fastest ATA 600 SSD'

'Vertical NAND opens up a whole new world when we look at SSD **endurance, density, battery life** for portables, and last but not least, SSD **performance.**'

'3D V-NAND ensures better performance and durability'



2006

2008

2012

2013

2013

2014

1<sup>st</sup> Samsung  
SSD

1<sup>st</sup> 2bit MLC  
SSD

1<sup>st</sup> 3bit  
SSD

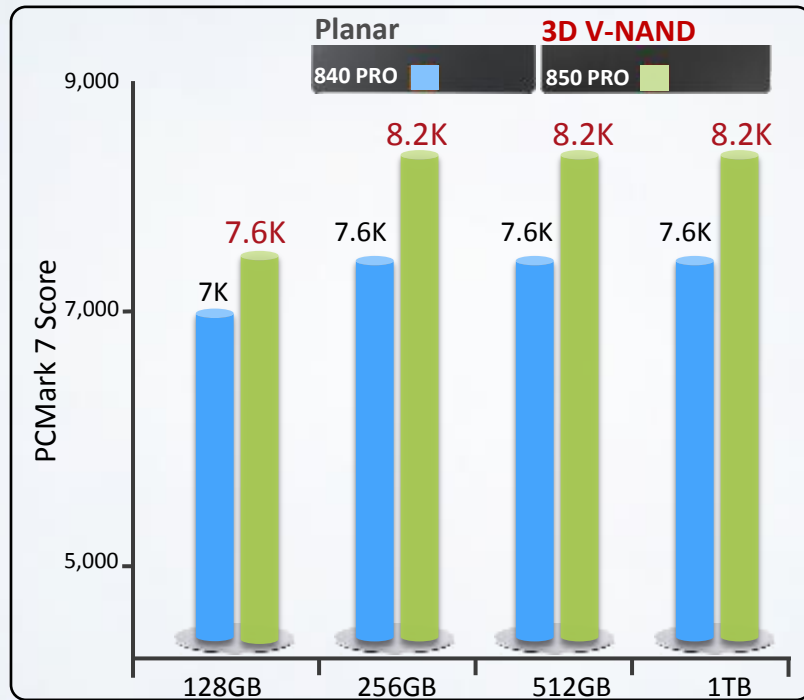
1<sup>st</sup> PCIe PC  
SSD

1<sup>st</sup> 3D  
V-NAND SSD

1<sup>st</sup> 32 Stack  
V-NAND SSD

# V-NAND 850 Pro

## Performance

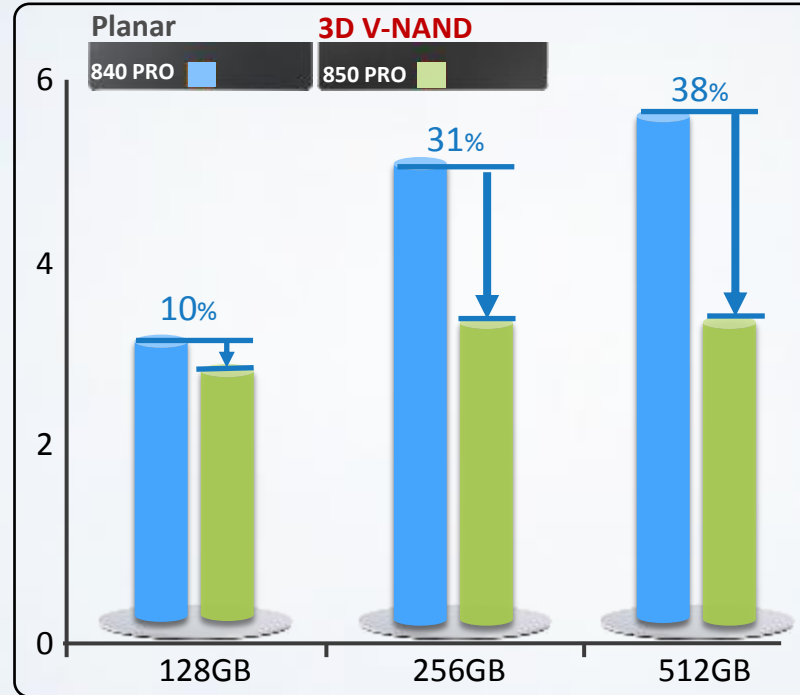


V-NAND Performance Leadership



# V-NAND 850 Pro

Active Power[W]



Up to 38% Lower Power





# V-NAND 850 Pro



Twice the Lifetime

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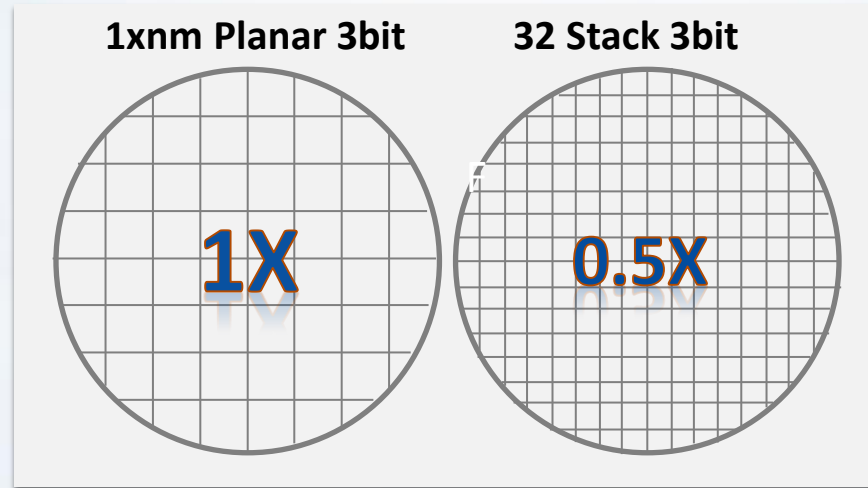
# V-NAND

## But Wait, There's More...



# Announcing World's 1<sup>st</sup> : 32 Stack, 3bit V-NAND

## 32 Stack 3bit cell



2X Density



# Disruptive Density

24  
Stack  
2bit



Three Sixty Residences  
(24 Floors)



32  
Stack  
2bit



One California  
(32 Floors)



32 Stack  
3bit



101 California Street  
(~48 Floors) Effectively



1<sup>st</sup> 3D V-NAND Mass Product



2<sup>nd</sup> 3D V-NAND Innovation



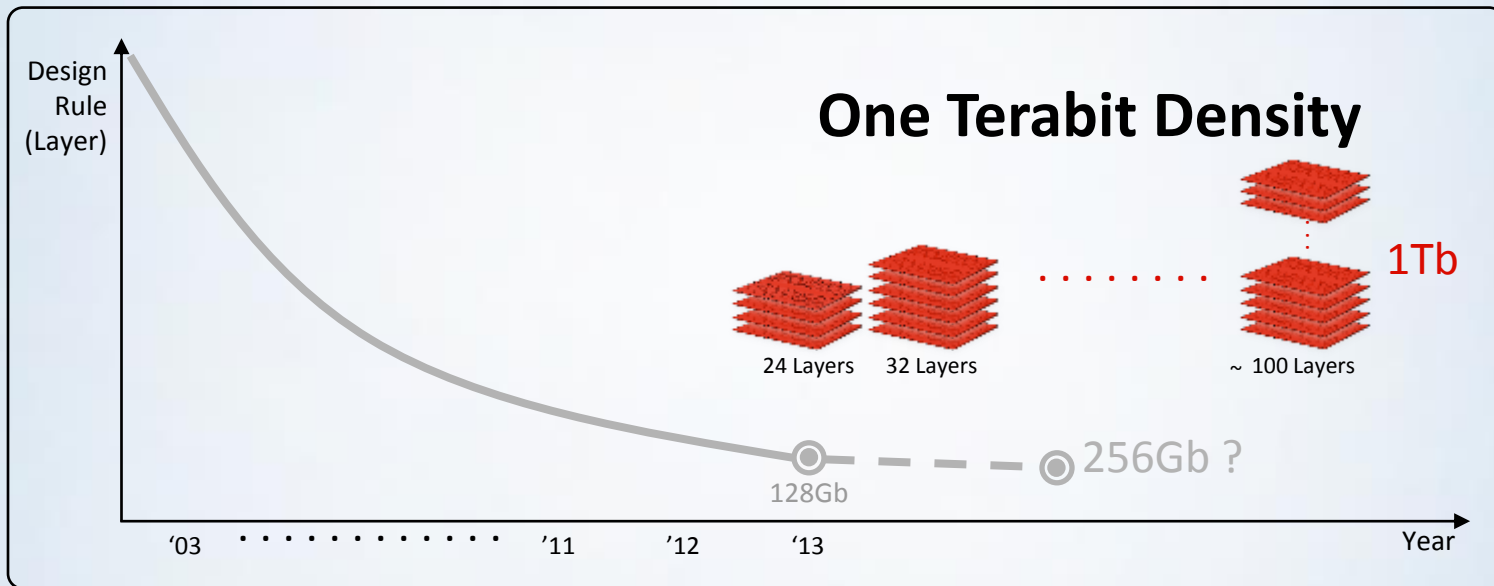
New Innovation (3bit)



New Era of 3D V-NAND

SAMSUNG

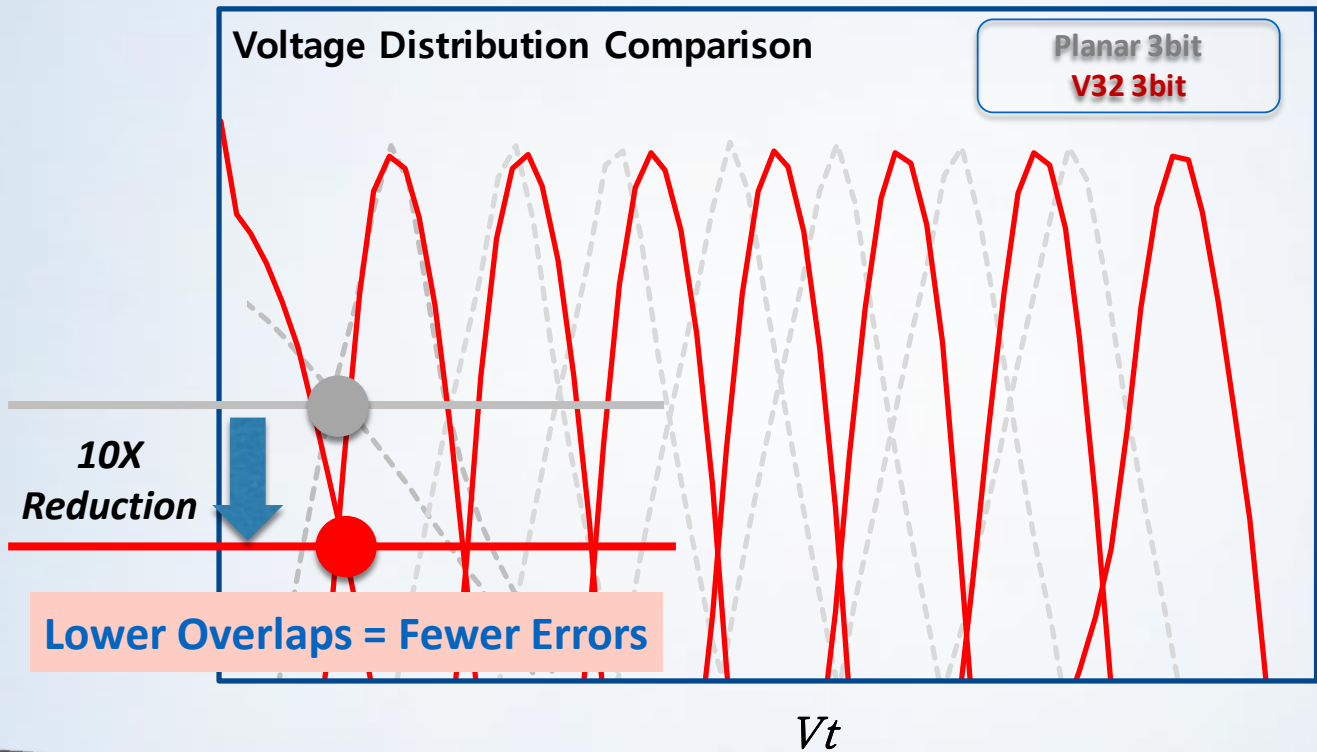
# V-NAND Density



3bit 3D V-NAND Enables Capacity to Scale...



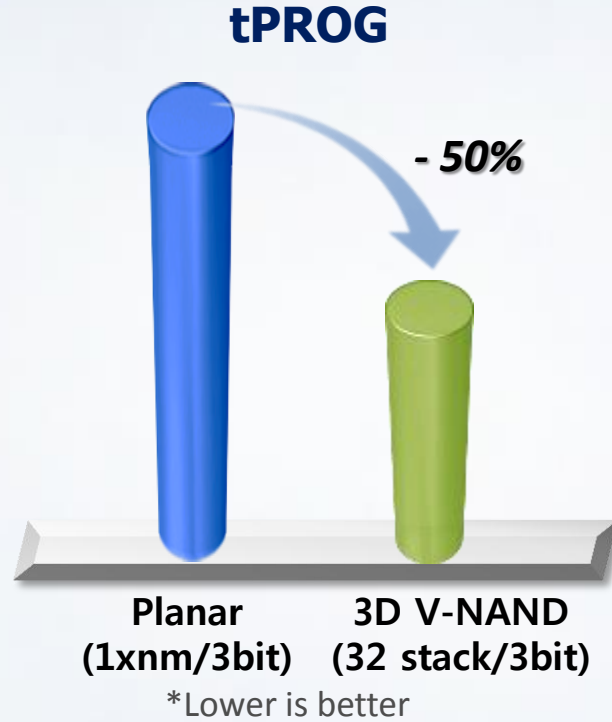
# V-NAND Reliability



3bit V-NAND Improves Bit Error Rate



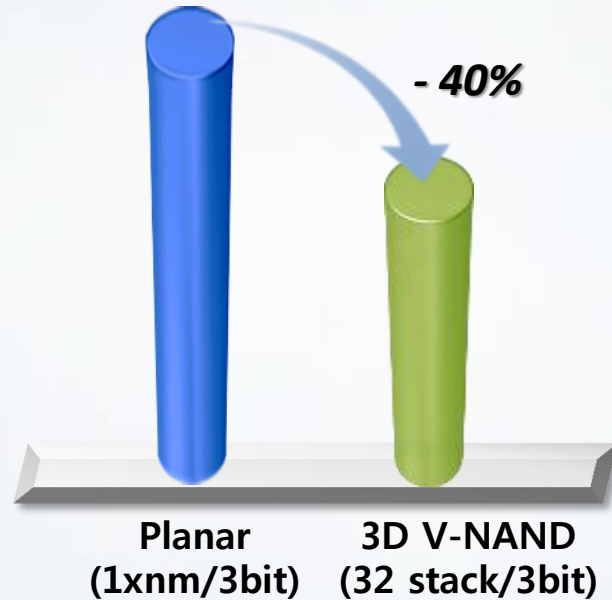
# V-NAND Speed



**2X Faster**

# V-NAND Power

## Consumption @ Read



\*Lower is better



~40% Lower Power



# Coming Soon : 1<sup>st</sup> 32 Stack Cell 3bit-based SSD

## The World's First 3bit-based 3D Vertical NAND Flash Memory

Breaking Through the 10nm Process Barrier  
with Innovative 3D V-NAND Technology



2006

1<sup>st</sup> Samsung  
SSD



2008

1<sup>st</sup> 2bit MLC  
SSD



2012

1<sup>st</sup> 3bit  
SSD



2013

1<sup>st</sup> PCIe PC  
SSD



2013

1<sup>st</sup> 3D  
V-NAND SSD



2014

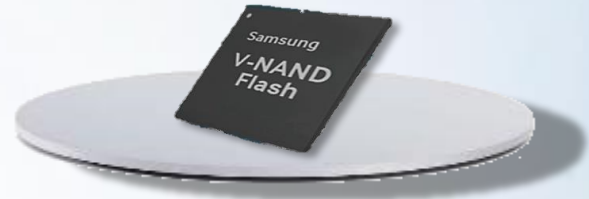
1<sup>st</sup> 32 Stack  
3bit V-NAND

# Overview

## 1. Industry Trends



## 2. 3D V-NAND



## 3. NVMe SSD



# 2014: World's 1<sup>st</sup> NVMe SSD in Production



# NVMe SSD: High Performance, Low Latency



600MB/s



10  $\mu$ s



7X

Bandwidth



4GB/s



1/3 X

Latency



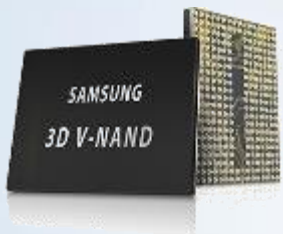
3  $\mu$ s



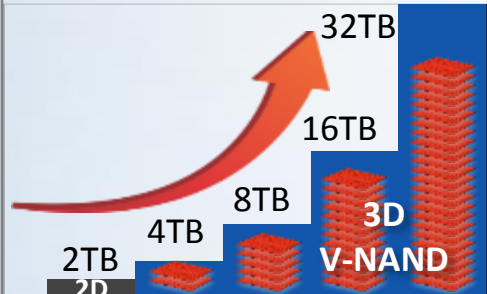
NVMe Unleashes V-NAND

SAMSUNG

# Better Together



## High Capacity



## High Performance

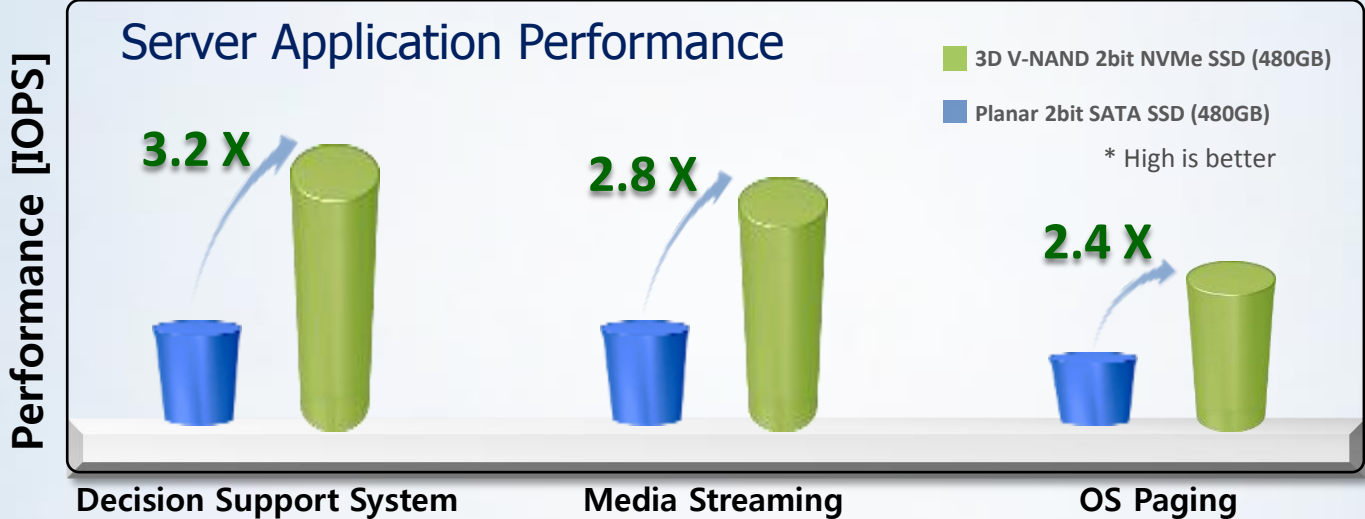


## Best TCO



World's 1<sup>st</sup> NVMe V-NAND SSDs in Production

# NVMe Performance



SSD IOPS → Application Speedup



# NVMe Enterprise Leadership

## ***SM1715 / XS1715***



**Performance**

**3000/1400 MB/s**

**750K/115K**

**Power**

**10-25W**

**World's 1<sup>st</sup>, Available Now: Dell PowerEdge Series**

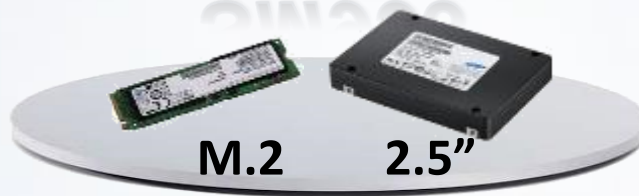
**SAMSUNG**





# NVMe Datacenter Leadership

## SM953



M.2

2.5"

Performance

2200/850 MB/s

300K/14K

Power

<6W

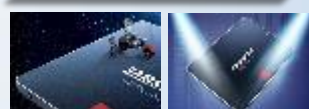
Datacenter TCO Optimized, Available Soon

SAMSUNG

# Leadership V-NAND, Leadership Solutions



**2014**  
1st V-NAND  
NVMe SSDs



**2014**  
1st 32 Stack  
3bit V-NAND

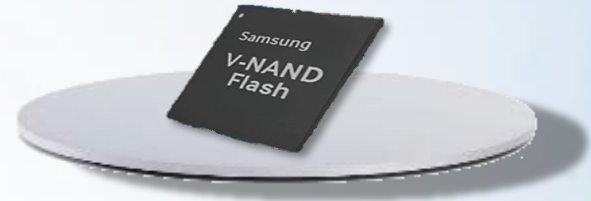


# Overview

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## 4. New Solutions

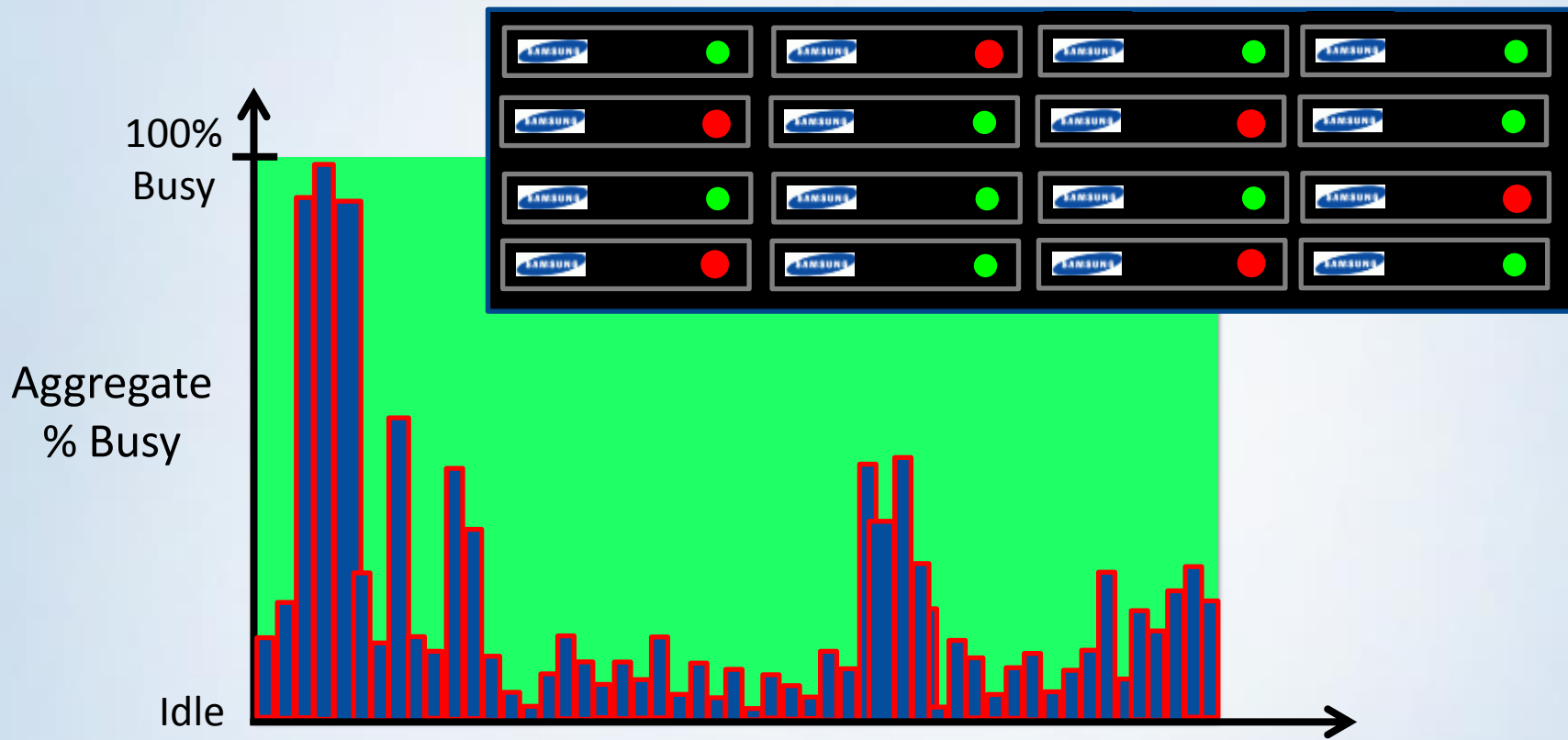


# Announcing

## Storage Intelligence



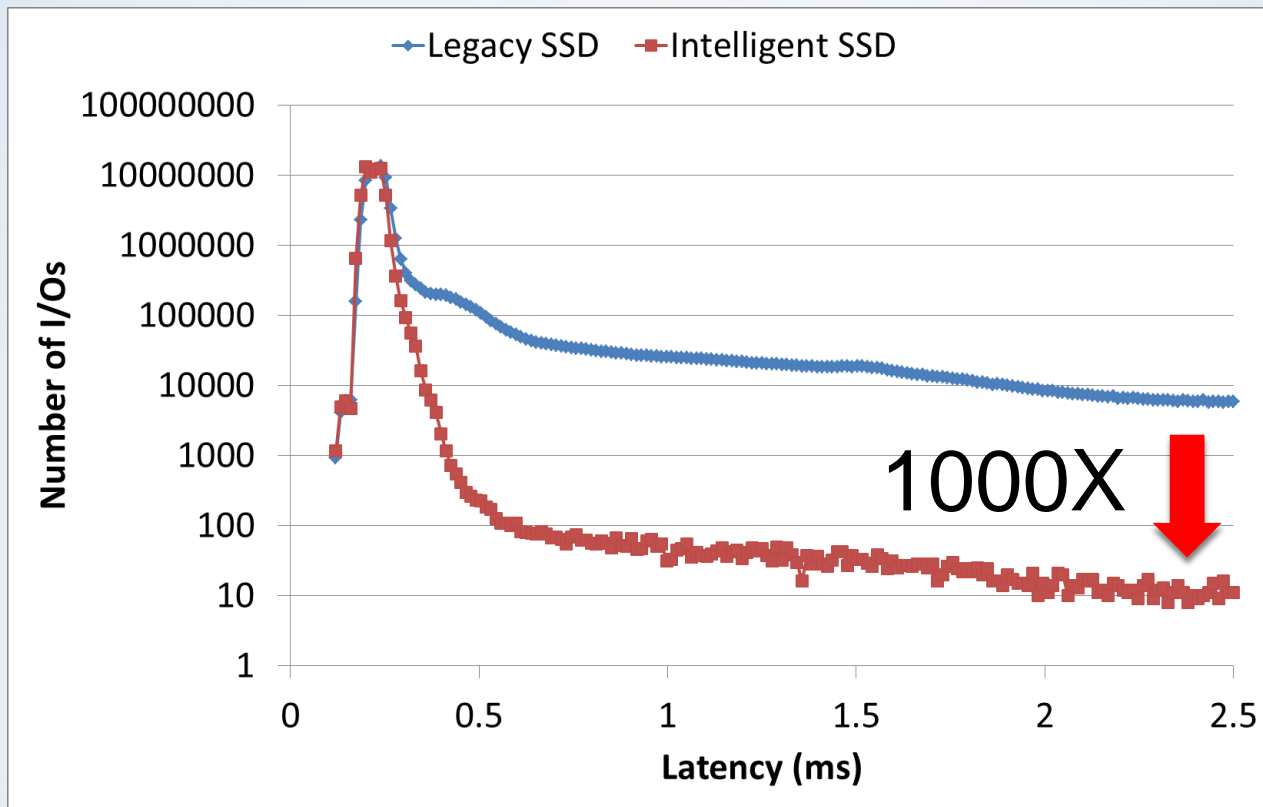
# Storage Intelligence: What if?



Harness SSD Compute Capacity?



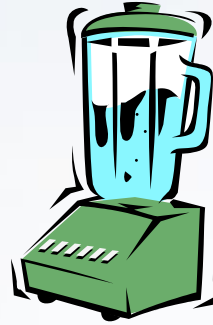
# Storage Intelligence: Garbage Collection



Deterministic, Low Latency

# Storage Intelligence : Multi-Stream

Legacy SSD

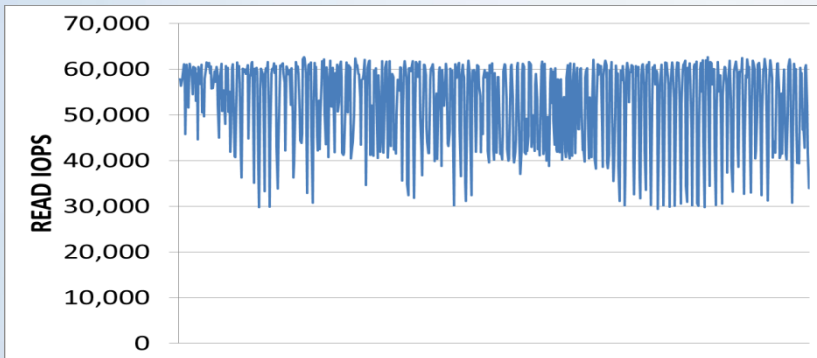


Multi-Stream



# Multi-Stream Results

## Legacy SSD



## Multi-stream SSD

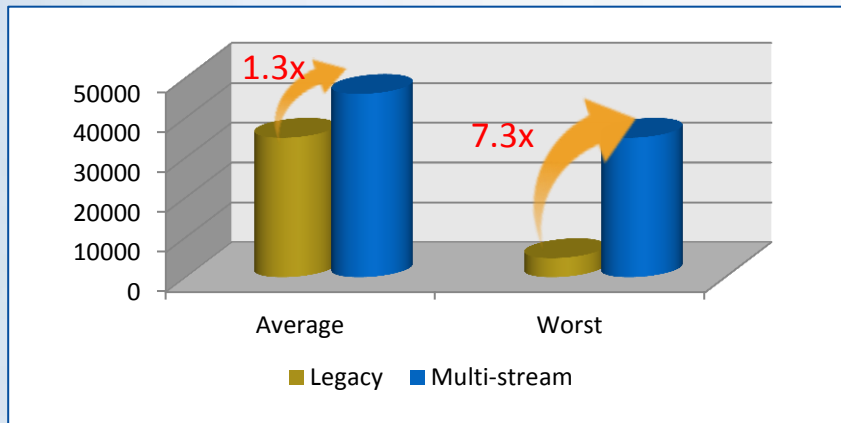


Deterministic Latency



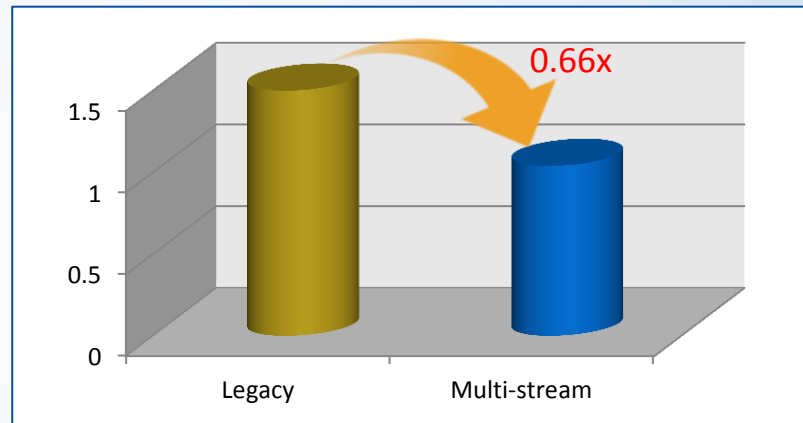
# Multi-Stream Advantages

## Read IOPs



Deterministic Performance

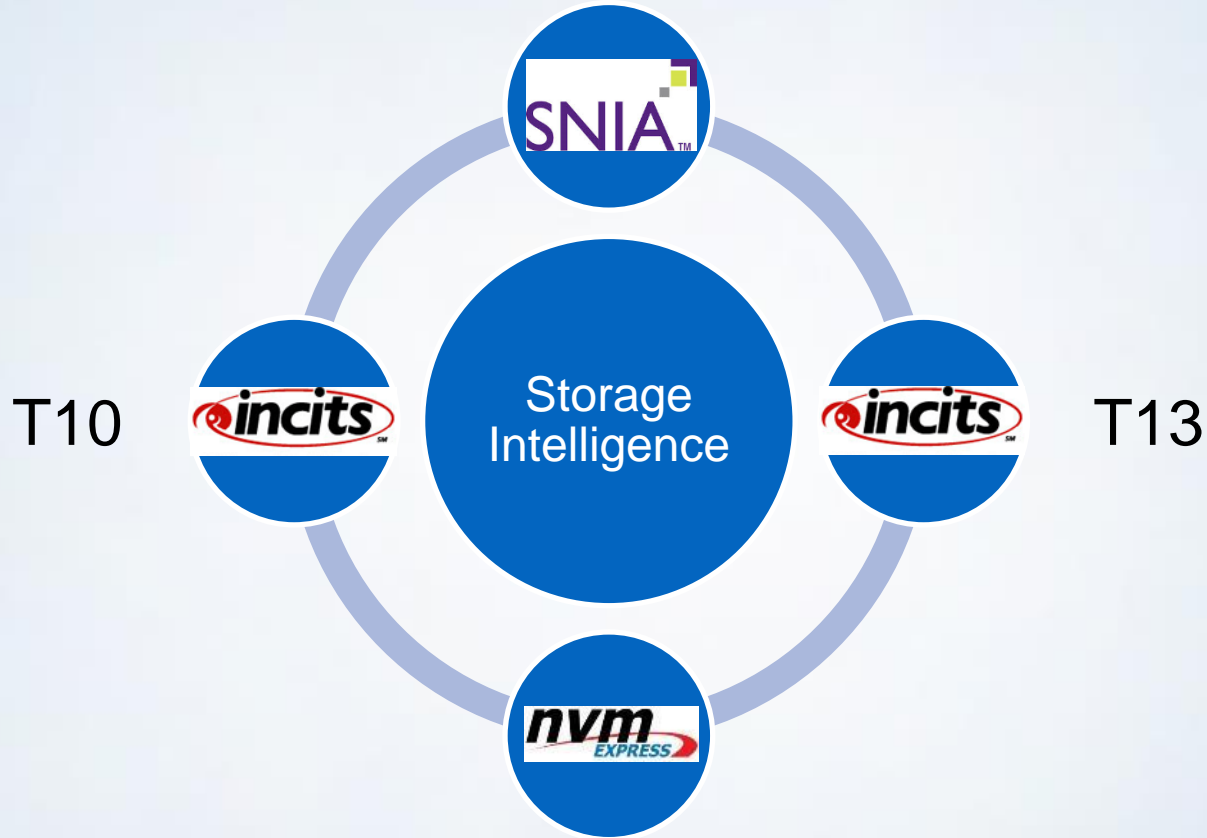
## WAF



1/3 Less Write Amplification

Performance and Endurance

# Opportunity for Industry-wide Collaboration



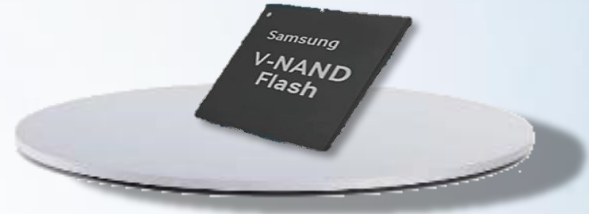
Redefine Computational Intelligence Together...

# Final Thoughts

## 1. Insatiable NAND Demand



## 2. 32 Stack 3bit V-NAND



## 3. 1<sup>st</sup> NVMe SSD in Production



## 4. Open Storage Intelligence



# Thank you!

