Most Advanced NAND Flash – 16nm

The Sea Change within a Sea Change for Enterprise Storage

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The First Sea Change
RAID

Redundant Array of Inexpensive Disks

Large Dimension Proprietary Disk

RAID HDDs

SSD-Based Arrays in the Enterprise

Second Sea Change

Bridge from HDDs

Same enclosures, protocols, interoperability

But …

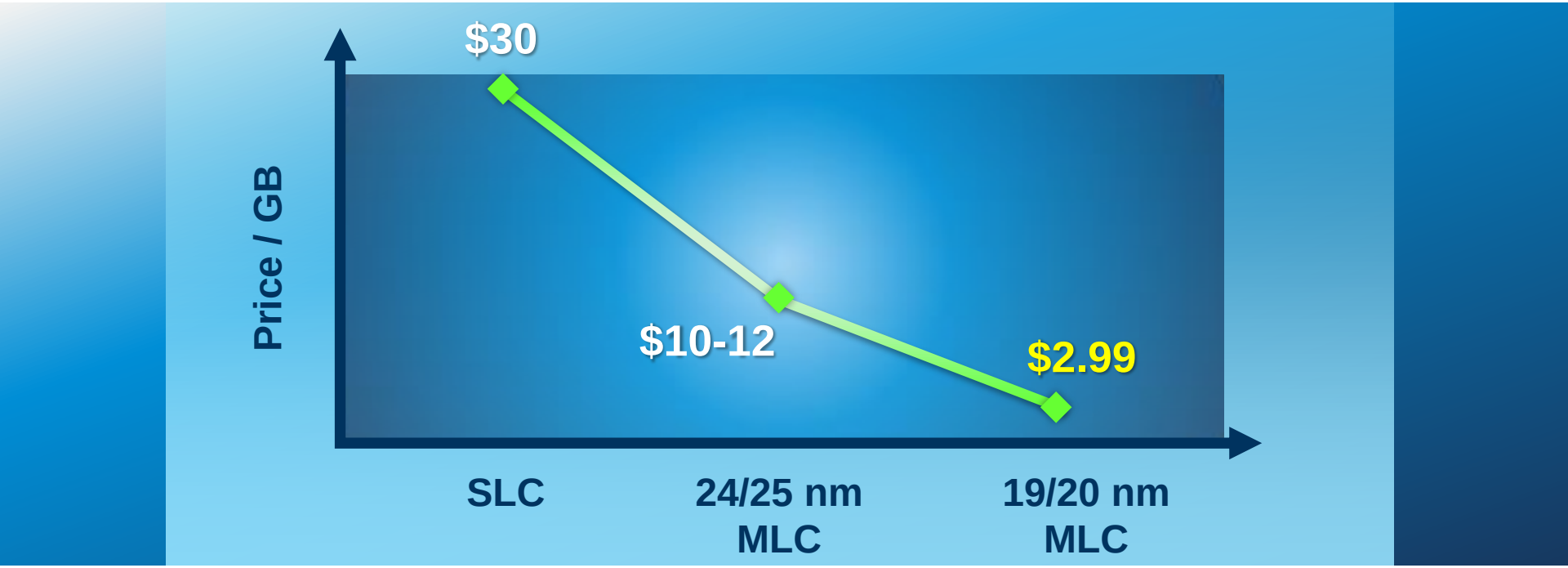
- Too expensive
- Too much power consumption
- Too much weight
- Too big
- SATA/SAS performance bottleneck

Sea Change within a Sea Change …

- All-Flash Arrays
  - Storage blades (SWP)
  - High-speed interconnect
  - New Flash Controller
  - Solid-state RAID
    - Reliability, endurance, performance
- Using the Most Advanced NAND Flash
  - 2012: 19/20 nm at $2.99/GB

Price Parity with HDD-based Systems

Sea Change within a Sea Change …



- 19/20 nm MLC competes head-on against SLC and eMLC for reliability, endurance, and performance
  - RAID-SE: 1 Million times more reliable than RAID-5

What's Next…
Most Advanced NAND Flash (16nm)

- Must go beyond 20nm consumer MLC to realize the all-Flash data center
- 16nm cMLC will ***NOT WORK*** as-is for enterprise storage

  → Requires customizations to become what we call…

  Most Advanced NAND Flash or MAN Flash™
- Customizations can negatively affect some parameters
  - For example, eMLC only needed 3 months retention without power (vs. typical 1 year retention)
    - Trading off retention → more P/E cycles

Most Advanced NAND Flash (16nm)

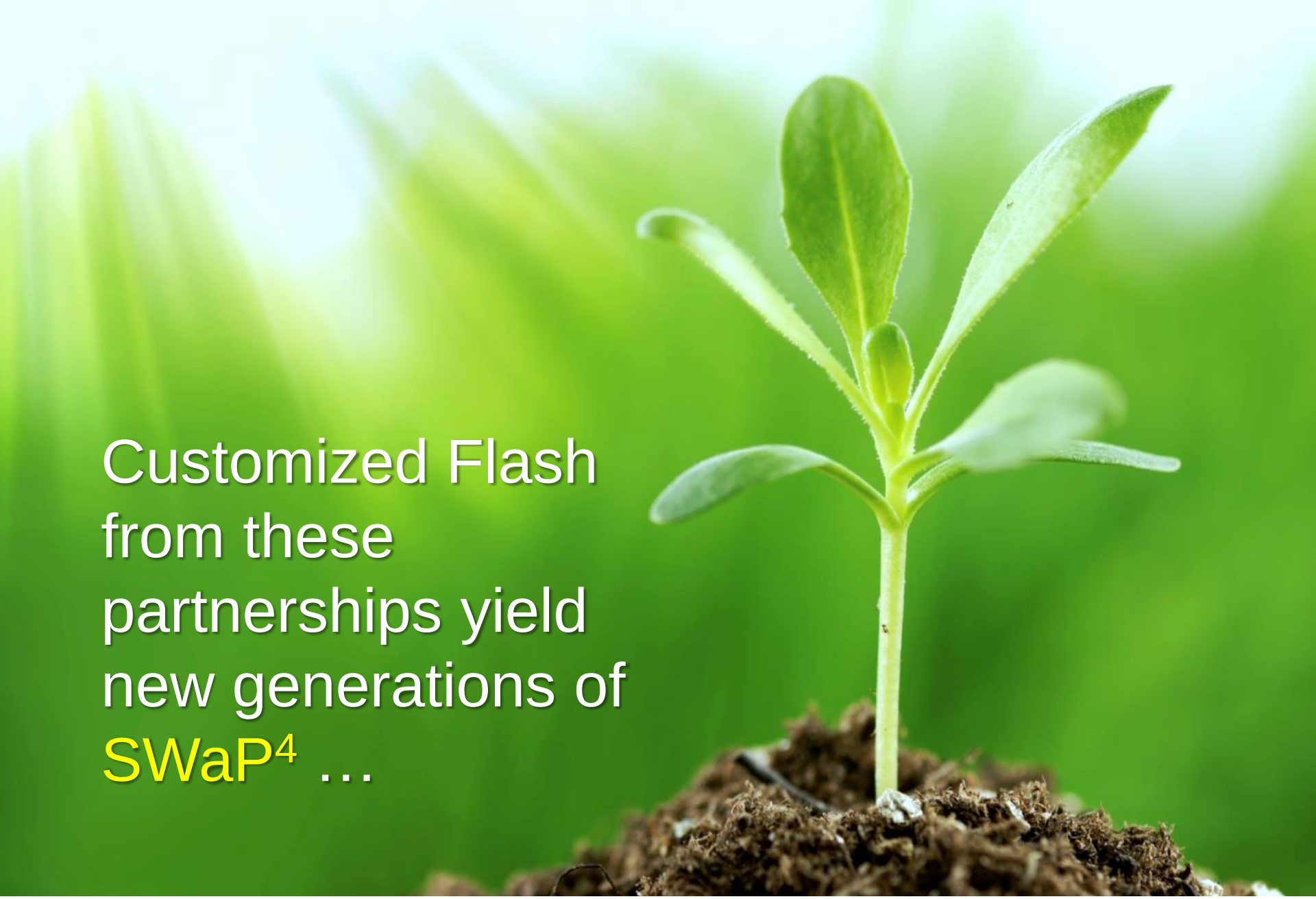
- Intimate Flash knowledge needed to customize off-the-shelf specs
  - Adaptive dynamic re-trimming
  - Close coupling with Flash controller
- Custom-built arrays can balance system and MAN Flash™ parameters
- MAN Flash™ separates the MAN from the boys

MAN Flash with Enterprise Customizations

The Dawn of a New Era

Partnerships With
Leading Suppliers

SK hynix **Toshiba**



SWaP⁴

Flash Memory SUMMIT

- **S**ize
- **W**eight
- and
- **P**ower
- **P**erformance
- **P**lug-and-play
- **P**rice

Key decision criteria for evaluating storage

skyEagle – *500 Terabytes*

MAN Flash + system-wide hardware = superiority on ALL fronts

Size
1 RU

Performance
5M IOPS

Weight
38 lbs.

Plug-n-play
<10 minutes

Power
800 watts

Price
$1.99/GB

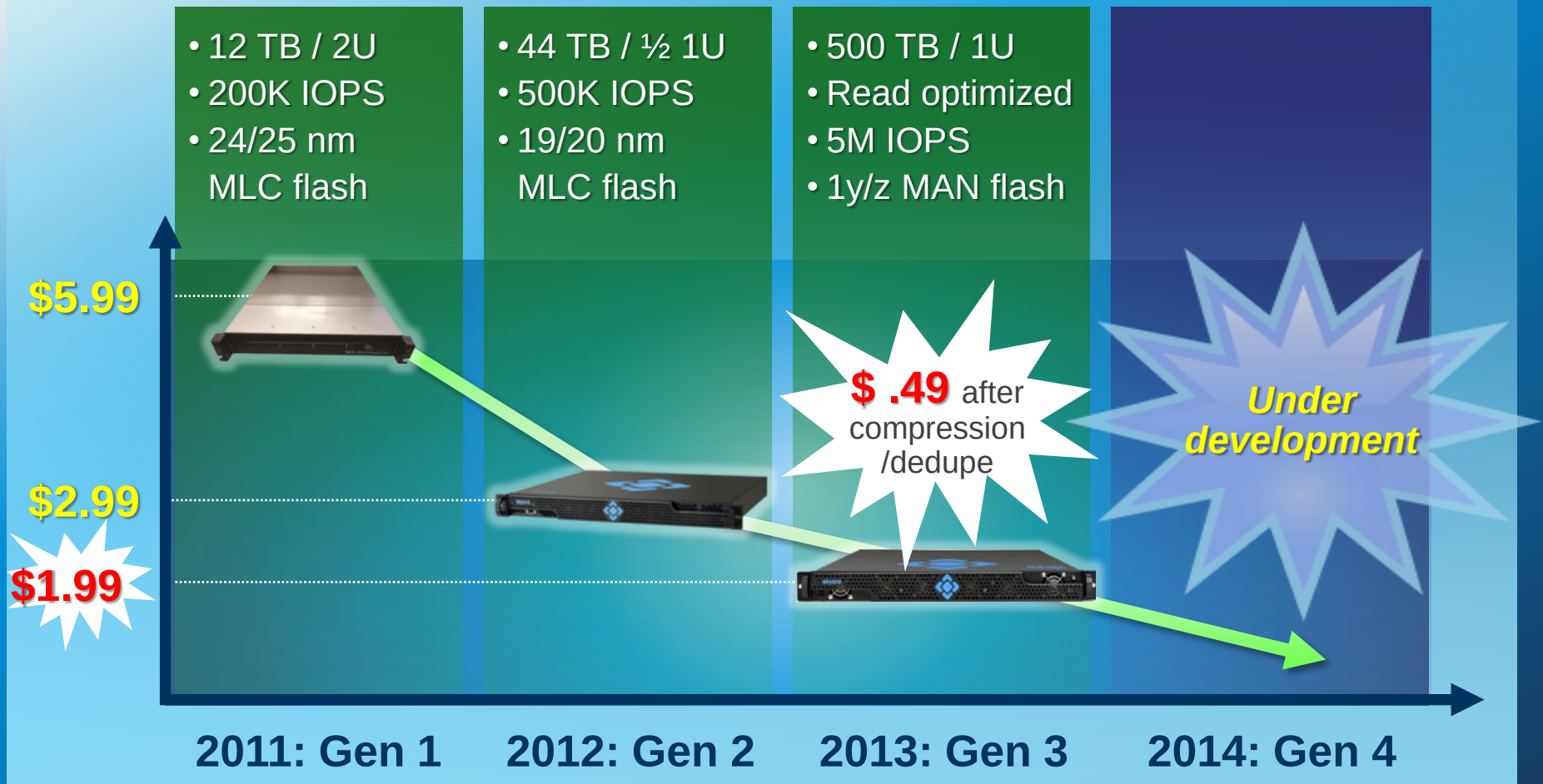
Priced *Less Than* HDD-based Systems

SSD-based vs. Custom-built Arrays

- Some believe building SSD-based arrays is the path…
  - One supposedly gets more options to use different vendors
  - One can ride Moore's Law
- We don't believe in Moore's law, but ***"More Law"***
  - → ***More than 10 times capacity and performance in one year***
- Sometimes a picture is worth a thousand words…

Here's the Picture: 500 Terabytes

~~Price Parity with~~ Below HDD-Based System Prices



All-Flash Array Use Cases

- Size-Weight-Power (SWaP) markets
  - Federal, Oil & Gas - vehicles, ships, planes, remote locations
- Multi-petabyte iSCSI/NFS Public/Private Cloud Storage
  - Global Financial Services, Large MSPs, SaaS providers
- Mid-market in conjunction with replication infrastructure
  - Regional Telecoms, Manufacturing, Banking
- Media & Entertainment
  - Large Movie Studios
- Oil & Gas
  - Seismic Processing, Reservoir Management

Thank You!

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