nvm EXPRESS™

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NVM Express™ and PCI Express® for Mobile

Dave Landsman

SanDisk

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10th ANNIVERSARY Flash Memory SUMMIT

NVMe™/PCIe® evolving for client/mobile

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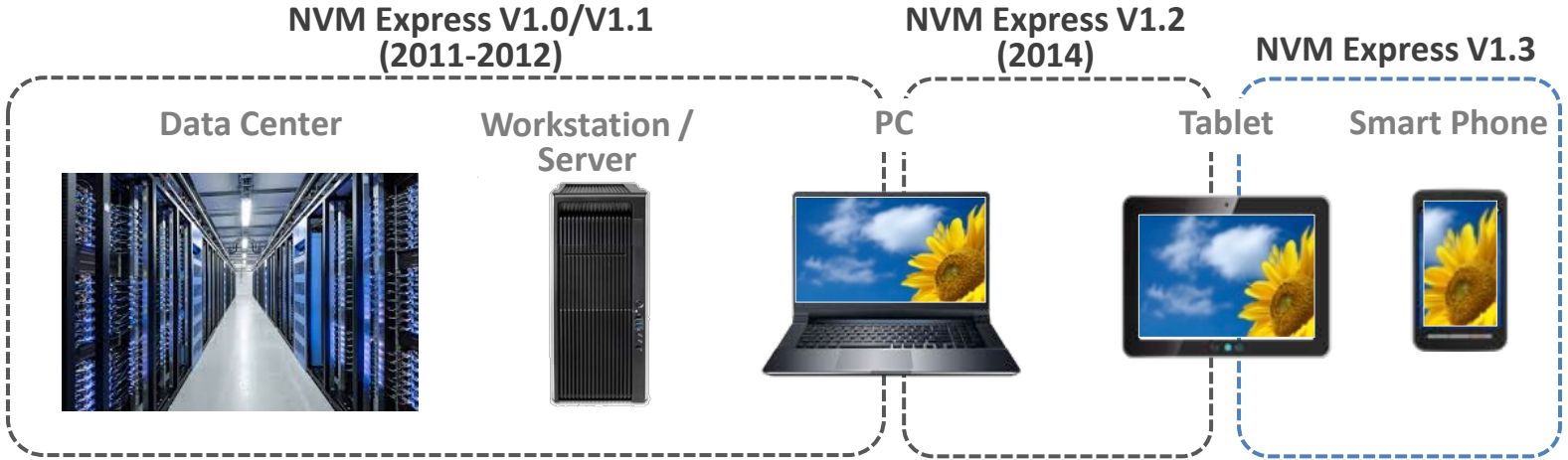
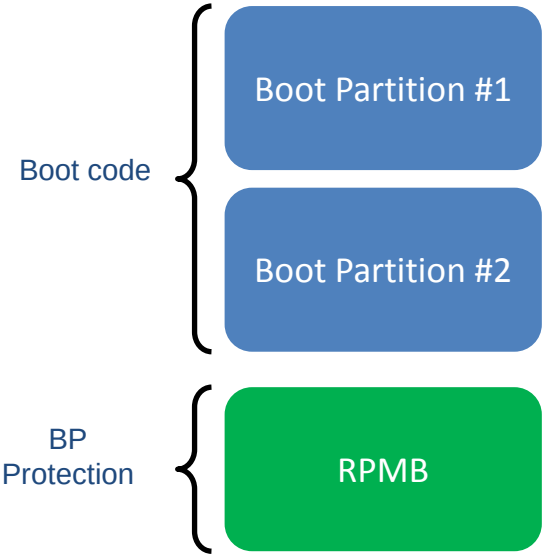


NVM Express	• Optimized for NVM • Low Latency • Exploits Parallelism • Efficient SW stack	• Host memory buffer • Replay Memory (RPMB) • Enhanced Power Mgmt	• ?
PCI Express	• No HBA	• M.2 • BGA for compute • L1.2 Sub-states	• ?

What more is needed in NVMe for mobile?

- Boot protocol for non-BIOS boot
  - Add Boot Partitions (BP) to store boot code
  - Read BP's with MMIO-based mechanism
  - Write BPs with enhanced FW commands
  - Protect/Lock BP's with RPMB
- Additional
  - Namespace Write Protect
    - General namespaces
    - Does not apply to boot partitions



Completing the pieces for NVMe/PCIe Mobile

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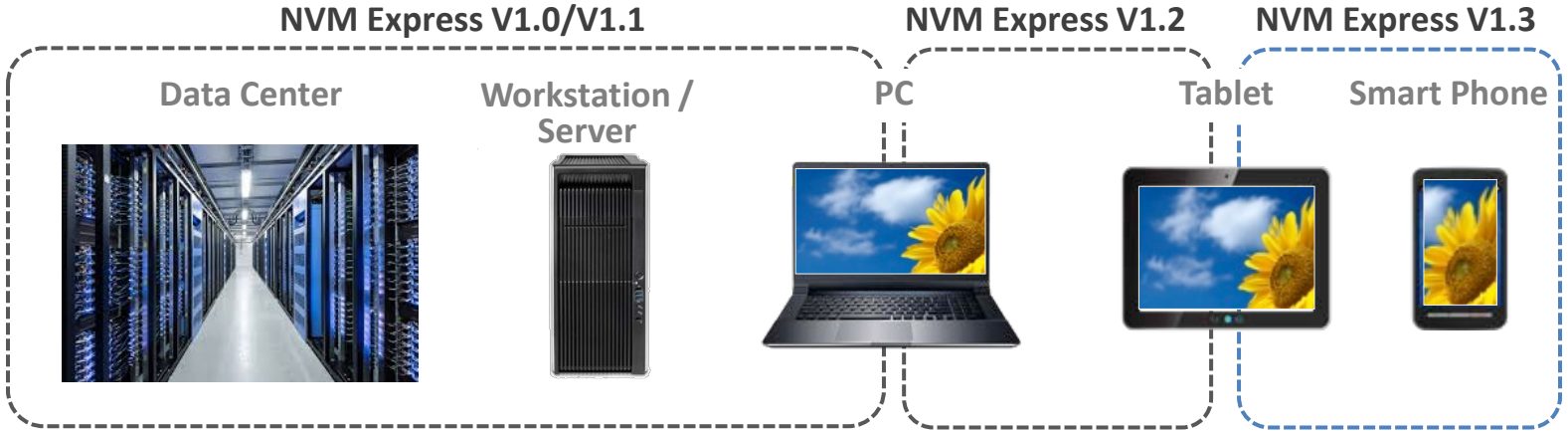

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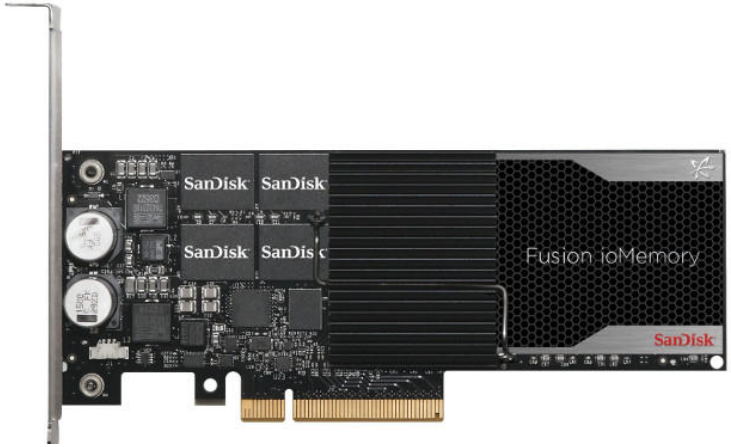
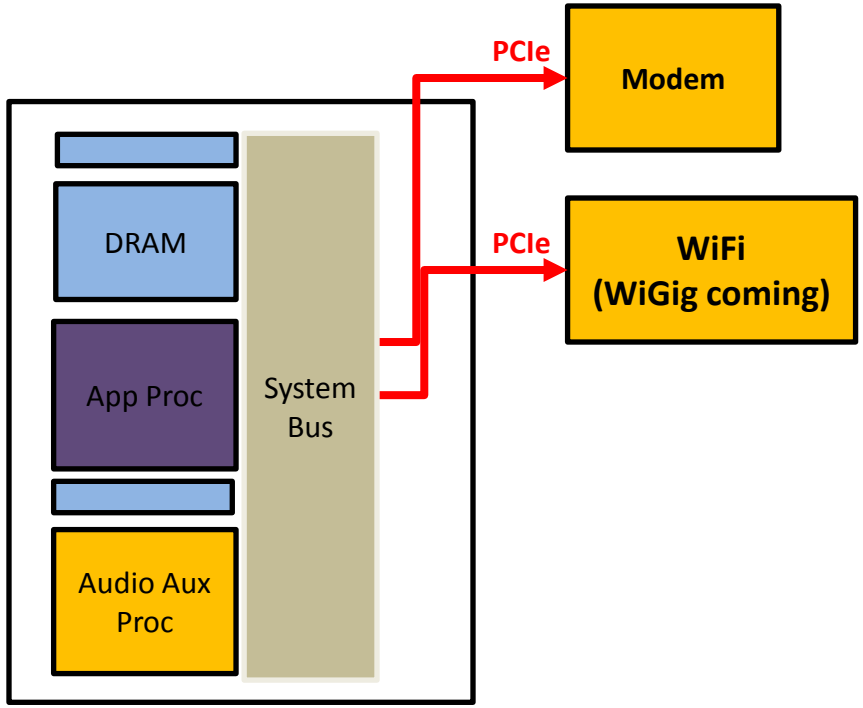
PCI Express and Power – Conventional Wisdom

- Conventional Wisdom
  - PCIe uses too much power for mobile



PCI Express and Power - Reality

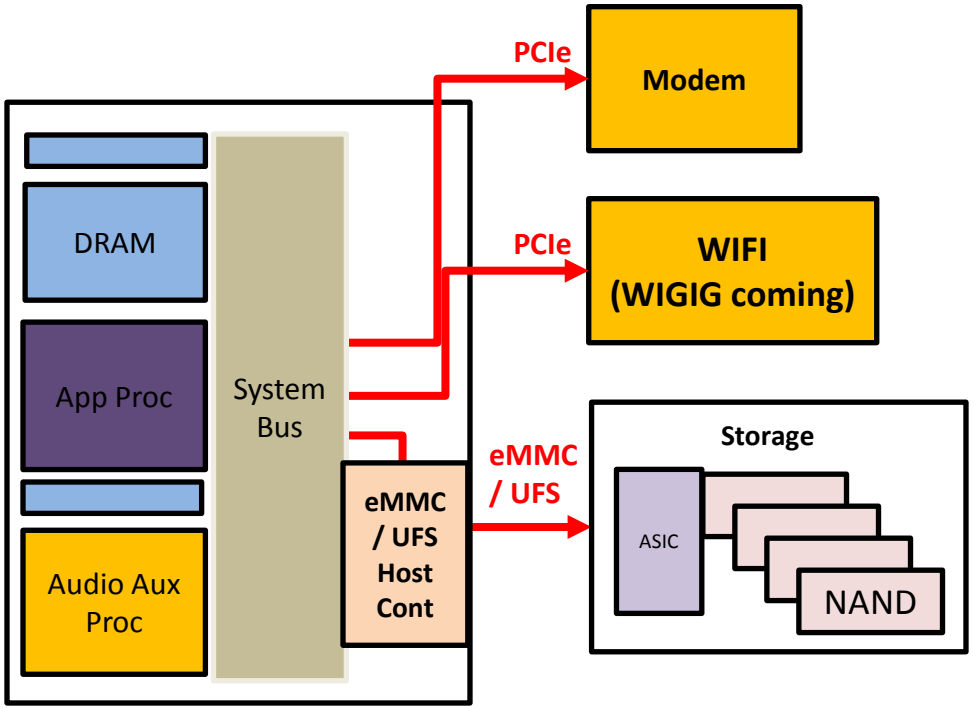
- Reality - Today
  - PCIe already used in mobile for wireless solutions
  - PCIe topology is simple in mobile
    - Few endpoints
    - Short channels
- Reality - When PCIe storage in mobile
  - Devices will be targeted at Mobile performance, not Client/Enterprise



PCIe in handsets today; will target mobile performance when in storage

Status quo in mobile storage interfaces

- Storage managed by host controller
  - eMMC
  - UFS (M-PHY)



PCI Express and Power - Reality

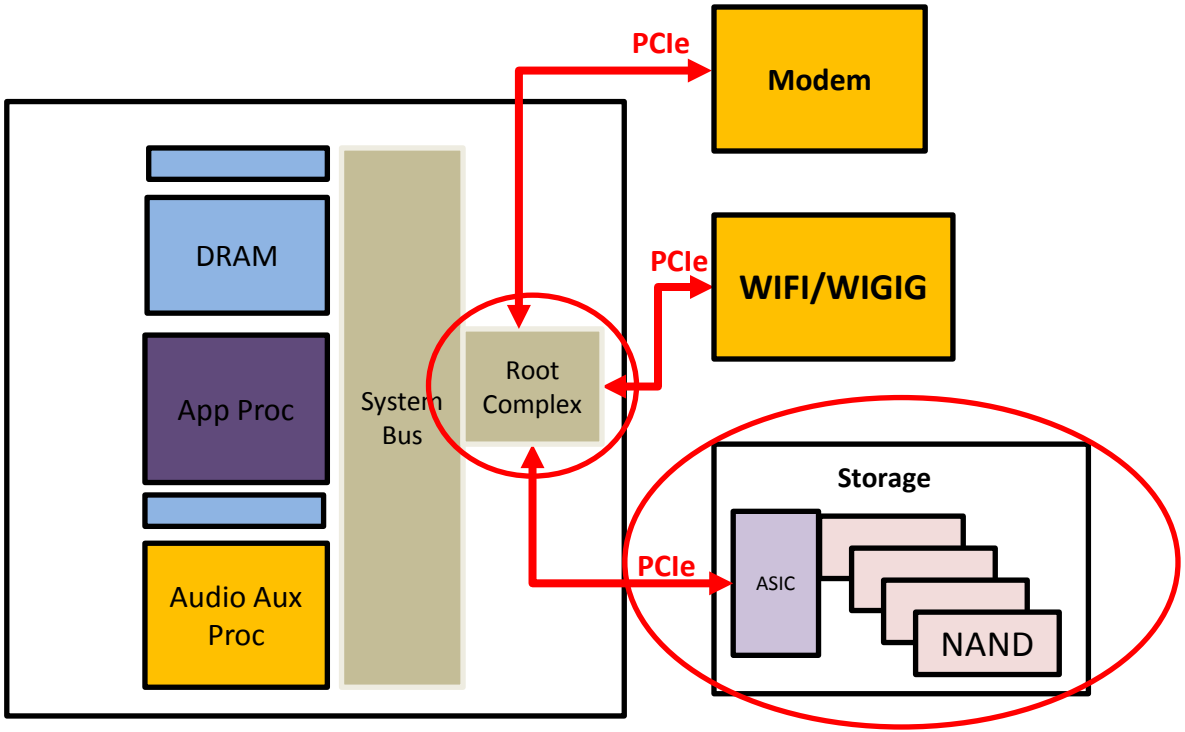
Single lane link power estimates

Item	PCIe Gen3	PCIe Gen2	M-PHY Gear3
Active Power* [mW]	60 (L0)	46 (L0)	58 (HS)
Standby Power* [mW]	0.11 (L1.2)	0.11 (L1.2)	0.2 (Hibern8)
Line Speed [Gbps]	8	5	5.83
PHY overhead	128/130 (1GB/s)	8/10 (500MB/s)	8/10 (583MB/s)
MB/mJ* (higher better)	14-18	8-12	8-12

- PCIe power on par with M-PHY power as mobile interface solution

Architectural Advantages for PCIe Storage in Mobile

- Given good PCIe PHY power characteristics, there are other advantages
  - Remove Host Controller
  - Engineering synergy
  - Root complex
  - HW Power Management



Summary: What is needed for PCI Express for Mobile?

- **Not** needed
  - Electrical changes
    - Implement existing architecture well (L1.2 sub-states, etc.)

- Needed
  - Smaller form factors
    - We have already
      - M.2
      - PCIe BGA for client/compute
    - Work starting in PCI-SIG on smaller BGA for mobile

Completing the pieces for NVMe/PCIe Mobile

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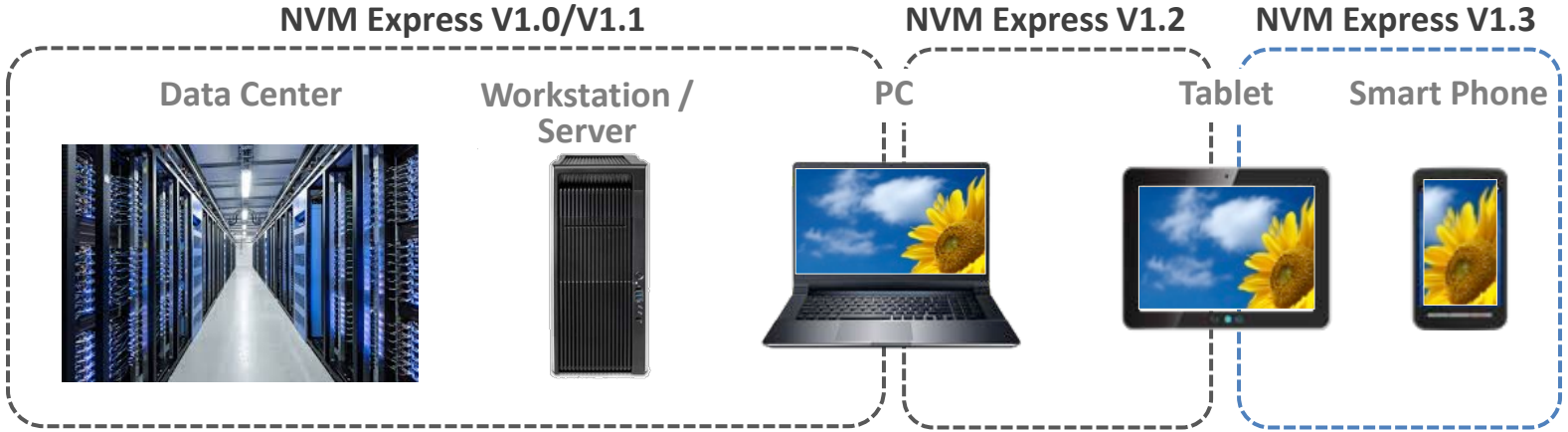

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NVMe/PCIe
Data Center to Mobile

10th Anniversary Flash Memory Summit

Call to Action – Mobile Ecosystem

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- Get involved w/ NVM Express and PCI-SIG®
- Consider NVMe/PCIe for your mobile solutions
- SoC vendors allocate PCIe ports for storage

Invest in the future of the storage ecosystem

Data Center to Mobile

Thank You


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HGST
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PMC
SEAGATE
Micron
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