NVMe™ Developer Days

Trends and Forecast for NVMe

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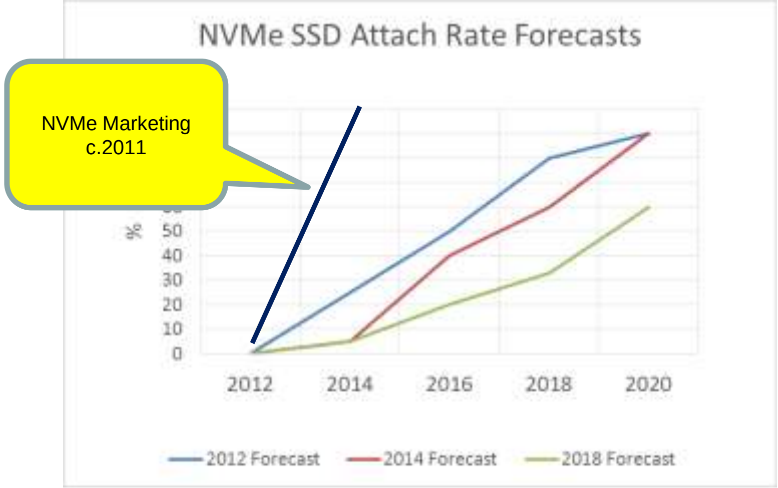
Thoughts on Technology Adoption



- If a new technology was absolutely the <u>undisputed perfect solution</u>, it would still take 5+ years to become dominant
  - Enterprise customers are much slower than this and more legacy driven
  - Nothing is a perfect solution (NVMe is close for now!)

<u>NVMe Hypothetical Example:</u>

- Intel decides we need storage protocol for Flash and new NVM technologies. Industry consortiums form
- Years later: First NVMe SSDs.
  - Apple goes all in
  - Alternative competing industry standards still being pushed
  - It's a high end niche
- Years later NVMe has range of products from multiple companies in Client and Enterprise
- Then we hit 50% adoption … now we focus on problems with getting to 90%+ (Tipping point)

Market Today

- Today: Client: 50% of PCs have SSDs (Q4’18) 40% of PC SSDs are NVMe
- Enterprise: 50% of Server SSDs are NVMe (Q4’18) . IOPs matter, NVMe is fastest
- Infrastructure: NVMe controllers now available from multiple 3rd Party companies and major SSD/NAND vendors
- Technology Need: NAND, 3D-Xpoint and Low Latency NAND can utilize speed
- Pricing: Controllers and SSDs can be made with a cost close to Sata/SAS.
- Pricing: NVMe SSDs were overpriced to maximize high performance segmentation. Competition is bringing down price in all markets to accelerate growth
- Applications and infrastructure (Key takeaway from NVMe-DD)
- End Result: the barriers are going away
  - “No one is using this, it’s a niche (gone)
  - “Its way overpriced. I can’t afford that” (gone)
  - “not enough controller companies and second sources” (gone)
  - “SATA is Fine, NAND is the limiter” Going away

Client Market Projections (SATA/NVMe Units and Capacity Shipped)

NVMe Capacity CAGR: 48% through 2025
Limited by Client TAM (~90% SSD Attach rate in 2025)

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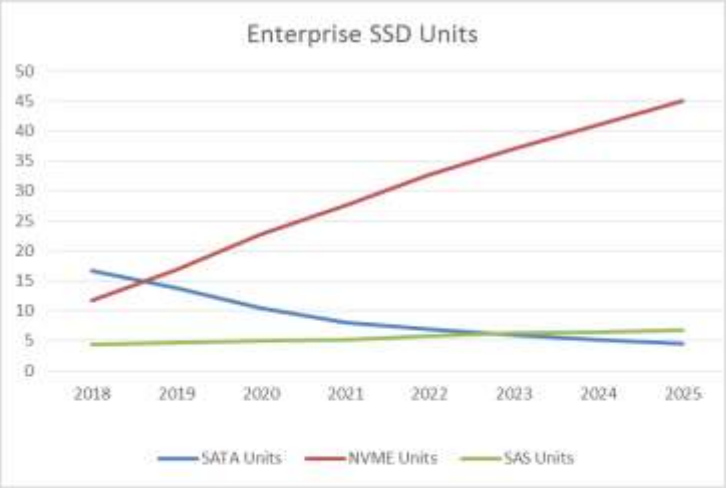
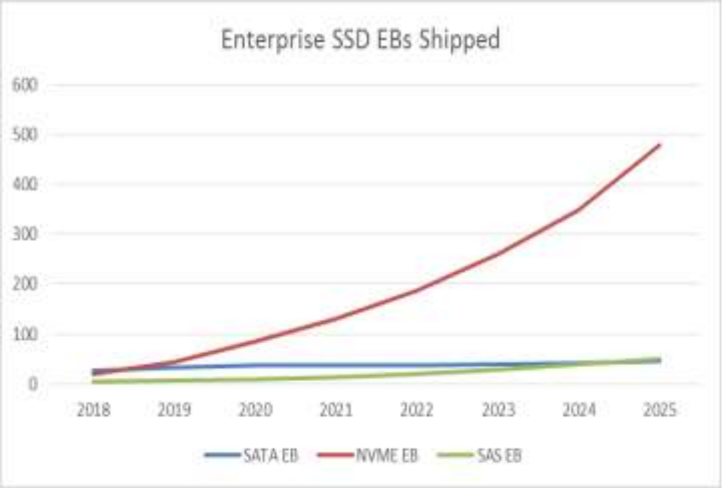
Source: IDC, IHS , Trendforce, Trendfocus, MKW Estimates
Client=Desktop,notebook,Tablet, 2in1, etc

Datacenter/Enterprise Market Projections (SATA/SAS/NVMe Units and Capacity Shipped)





NVMe Capacity CAGR: 57% through 2025
TAM, Attach rate, SATA Replacement, and Capacity all growing

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Source: IDC, IHS , Trendforce, Trendfocus, MKW Estimates

What is Needed for NVMe to Meet Projection?

- Multiple vendors in all market segments (high/low cost)
  - Increase controller support
  - Increased SSD types from NAND and from 3RD Party SSD companies
  - NAND continued scaling/QLC. Low latency NAND/new NVM Ramp
- Support for resolving NVMe Limiters. What is preventing adoption?
  - Support for legacy designs, systems, compatibility
  - New designs to make compatibility a non-issue.
- Data/Applications/Software to provide drive for adoption
  - Again, a key outcome for me from this conference
- Pull from PC OEMs-Hyperscale
- No replacement technology
  - Either actual or perceived

Thank You!

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