



SSD Cost-of-Test Using Non-PC Based Architectures

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Cost Of Ownership (COO)

- **Cost-Of-Test** = Capital equipment focused, single point of time calculation of test costs.

$$\text{Cost Of Test} = \frac{\text{Capital Equipment Cost}}{\text{Devices / Workcell}}$$

- **Cost-Of-Ownership** = Total cost to own and operate a piece of equipment over its useful life.

$$\text{Cost Of Ownership} = \frac{\text{Development} + \text{Deployment} + \text{Operational Costs}}{\text{Devices / Workcell}}$$

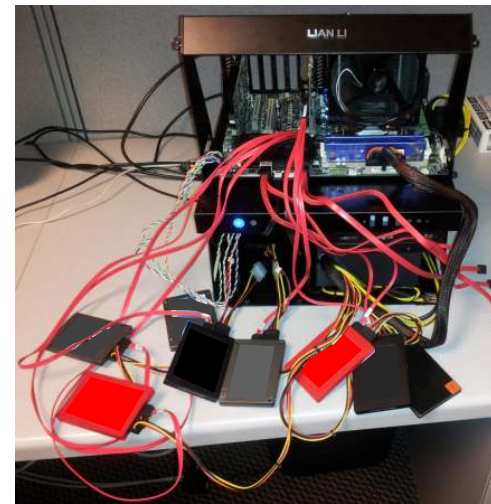
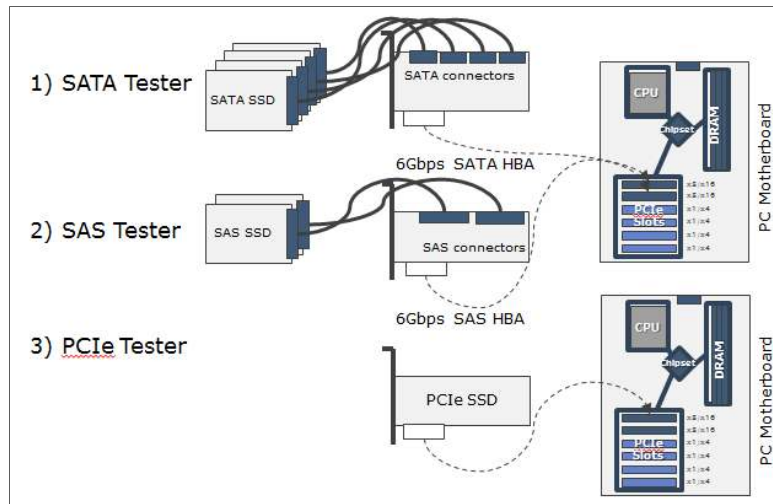
Development, e.g. research, tools, training, time

Deployment, e.g. capital equipment, software deployment

Operational, e.g. operators, maintenance, floor space, technology refresh, parallel efficiency, utilization

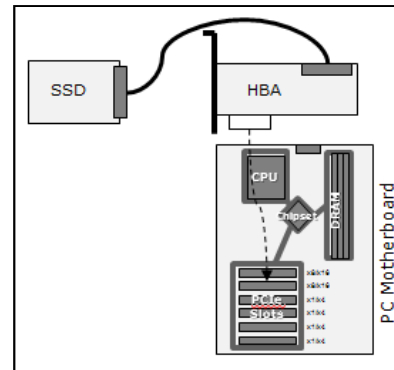
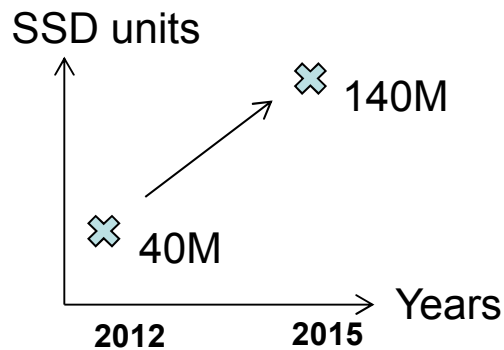
PC-based SSD Testers

- PC motherboard + Protocol Board (HBA) + Test Software

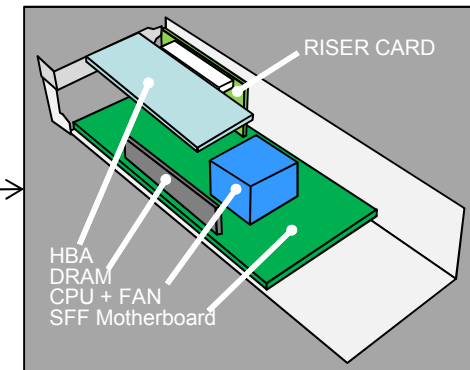


- Manual insertion for <1000 SSD per Tester
- Optional Oven for Characterization and Burn-in

Scaling challenge



1:1

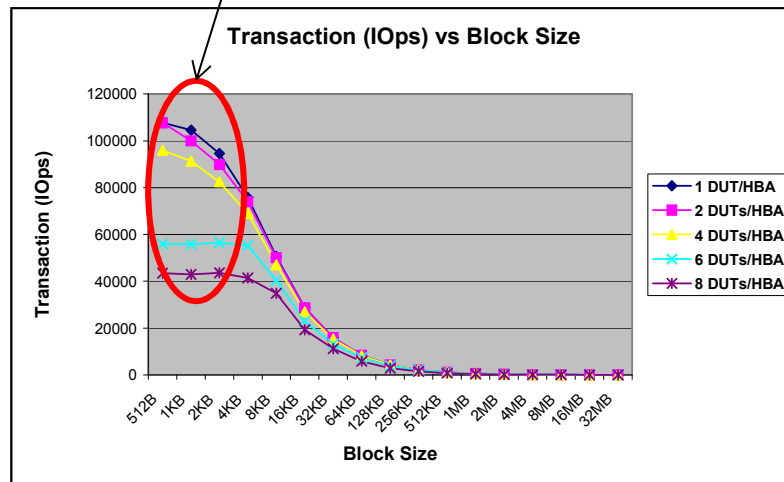


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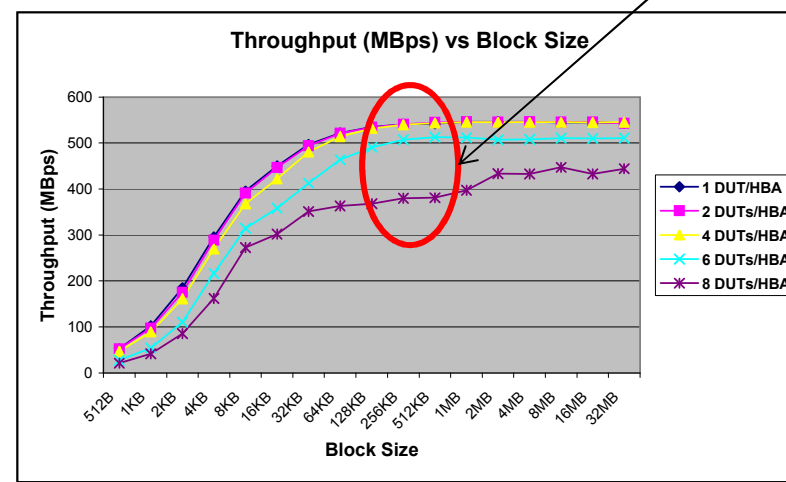
Approaches	Pro	Con
SFF Motherboards	< Footprint	> Cost, Heat, < Slots
Riser Cards / Extenders	< Height, Size	Signal integrity
Shrink Rack Space	> Parallelism	Heat, < Flexibility
Integrate HBA on Motherboard	< Footprint	> Cost, Fixed protocol
Shared Rails vs. Individual Supplies	< Cost	< Flexibility, Stability
HBA Sharing	> Parallelism, < Cost	Performance

Impact of Sharing

- IOPs starts dropping at 4 DUTs Sharing
- 60% drop at 8 DUT Sharing



- 30% drop at 8 DUTs Sharing



- Multi-DUT SATA performance drops with >4 SSDs*
- Performance dependent on CPU, OS & SW efficiency

* 3.7GHz i7 quad core PC w/ 8 port LSI HBA



Impact on Test Time

- Write 30TB of Data, 75/25 Read/Write Mix
Written Data is Read back and compared

	Full Performance	PC 1:8 Sharing
Total Writes (TB)	30	30
Total Reads (TB)	90	90
Write Speed (MB/s)	500	350
Read Speed (MB/s)	550	385
Compare Overhead	0%	10%

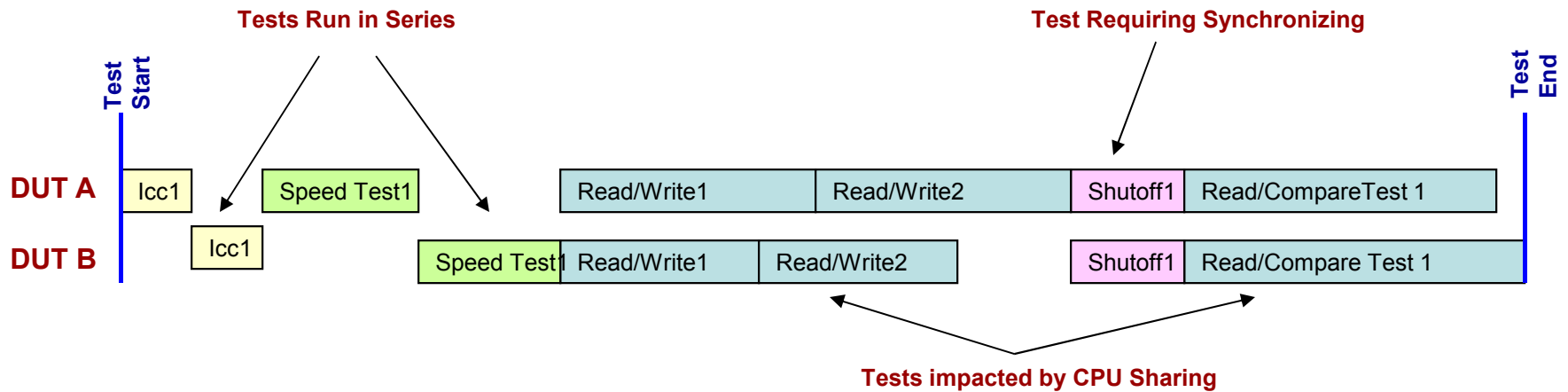
Write (h)	175	250
Read (h)	477	681
Compare (h)	0	68

Total Time (h)	651	999
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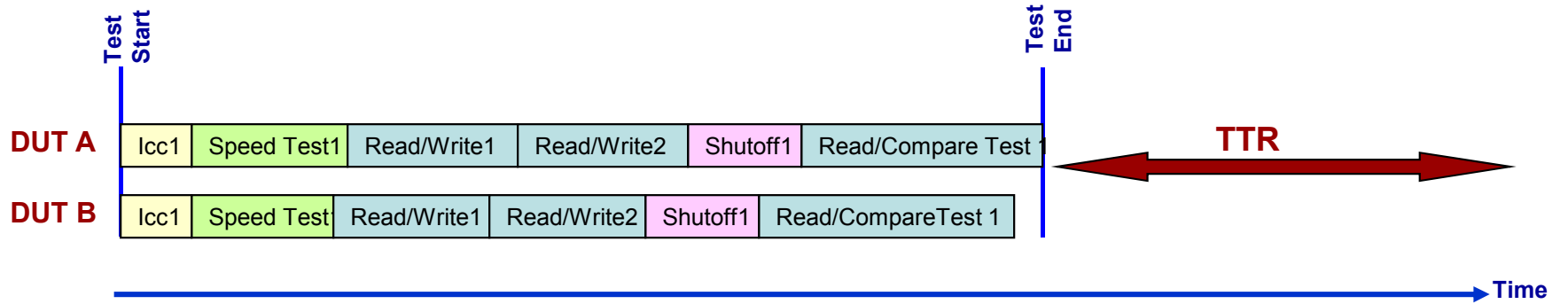
53% Longer

Shared Resource Overhead

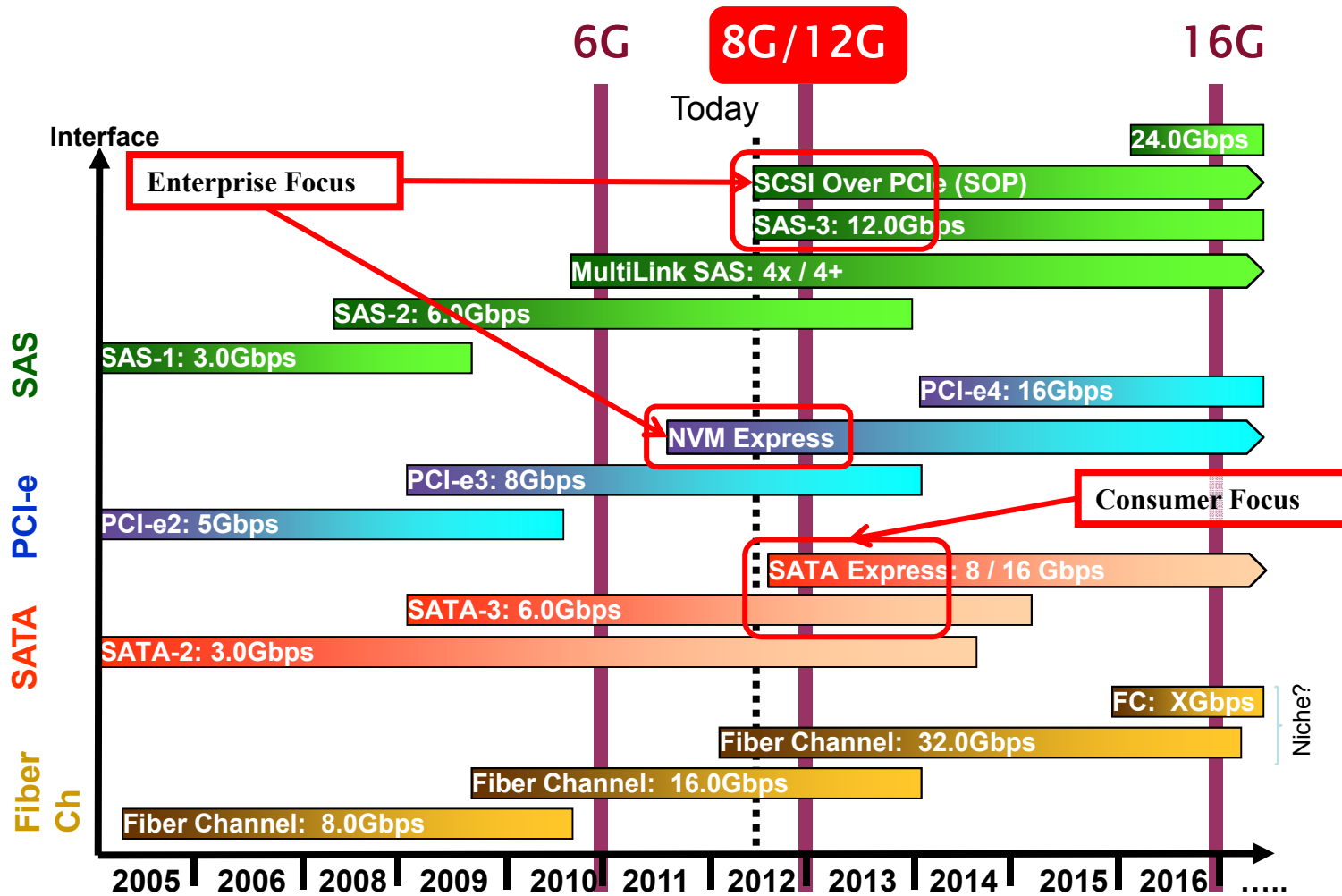
Share-Resource-Tester



Tester-Per-DUT

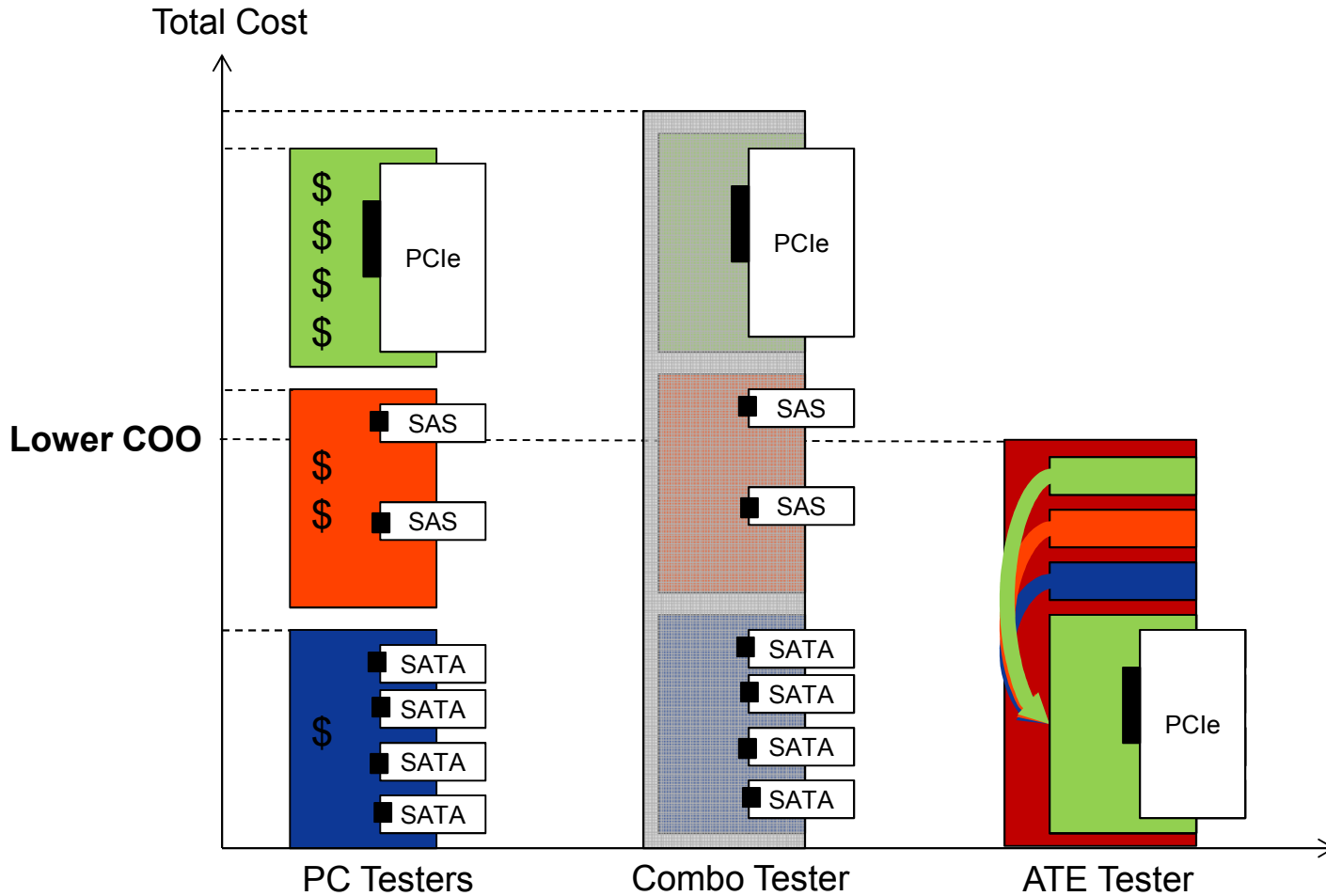


Product Mix Challenge



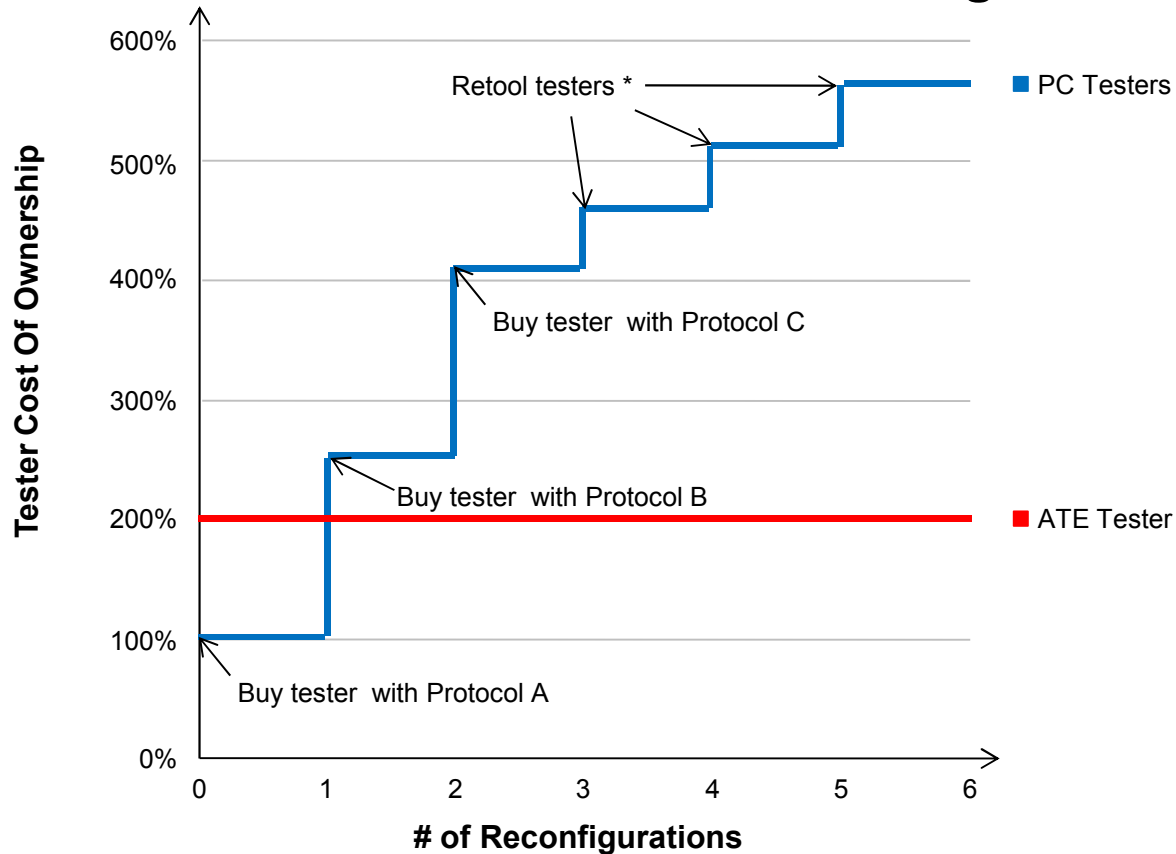
Equipment Cost Model

3 Protocol Cost Comparison



Reconfiguration Cost

COO vs. # of Product Mix Changes



* Major retooling can result in testers being retired or additional new purchases



Ideal Non-Shared ATE Tester

- Parallelism scaling without sacrificing performance or stability.
- Interface reconfiguration, on customer floor to enable mix product testing.
- Lower cost of ownership for multi-protocol solutions than dedicated PC testers.
- Longer tester life through tester upgradability.



Summary

- Limited technical differentiation between PC-based testers makes price the key purchasing decision for SSD test equipment.
- Advantest proposing ATE tester approach that improves Cost Of Ownership (COO) by providing:

Parallelism Scaling, Mix Product Testing and Tester-per-DUT Performance targeted at next generation multi-lane SSDs



References

- White Paper - The Real “Total Cost of Ownership” of Your Test Equipment - Agilent Technologies 2010
- Test & Measurement World - Do you know your true cost of test?, Richard McDonell, National Instruments – Nov 2009