

# SUPERTALENT ULTRADRIVE LE/ME PERFORMANCE IN APPLE MAC WHITEPAPER

2.5" SATA-II SOLID STATE DRIVE



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### 1.0 ABSTRACT

In March 2009 Super Talent introduced its UltraDrive series to market. In May 2009 Super Talent tested both the UltraDrive LE and UltraDrive ME in the Apple 13" Macbook, the 15" Macbook Pro, 17" Macbook Pro, Quad-core Mac Pro and the 8-core Mac Pro.

We easily upgraded the Hard Drive in the laptops to UltraDrives, enabling faster boot and better overall performance. We also installed multiple drives in JBOD, RAID0, RAID1 on the Mac Pro as both a secondary drive array and also as a boot drive array.

Both the UltraDrive LE and the UltraDrive ME performed very well across all of the Apple products. In the MacBooks we were able to cut boot time by up to 58%. We also learned that the performance of the UltraDrive ME was over 2.5x that of the standard Apple SSD and 5.4x that of the built in Hard Drive.

Through our Mac Pro testing, we see that performance doesn't vary greatly based on stripe size and that the UltraDrive ME performs close to the UltraDrive LE on all but small random writes.

### 2.0 PRODUCT OVERVIEW

#### 2.1 PRODUCT FEATURES

- Capacity: 32-256GB
- 64MB Internal Cache
- Form Factor: 2.5" HD (100.20mm x 69.85mm x 9.5mm)
- MLC or SLC Flash
- Fully compliant with SATA revision 2.6
  - Compatible with SATA 3.0Gb/s and SATA 1.5Gb/s interfaces
- Fully compliant with ATA-7 Standard
- PIO, DMA, UDMA (up to 6, dependent on host) supported
- Certified for Apple MacBook (13"), MacBook Pro (15/17"), and Mac Pro (4/8-core)
- Rugged Metal Case
- Minimum 10 year data retention
- Built in wear leveling algorithm
- Built in error detection and correction
- 100% tested HW and SW
- Designed and Manufactured in the USA

## UltraDrive LE/ME Performance in Apple Mac

### 2.2 PRODUCT ORDERING PART NUMBERS

The following products were used during our testing, they all had firmware version 1370 installed.

Product Family	Capacity	Flash	Channel/Retail Part Number	OEM Part Number
UltraDrive ME	64GB	MLC	FTM64GX25H	SX64B6X25H
	256GB	MLC	FTM56GX25H	SX56B7X25H
UltraDrive LE	32GB	SLC	FTD32GX25H	ST32A5X25H

Table 1: Tested Super Talent SSDs

### 3.0 TEST SETUP

#### 3.1 TESTED DRIVES

Name	Type	Capacity
UltraDrive ME	SSD	256GB
	SSD	64GB
UltraDrive LE	SSD	32GB
Apple Original	HDD	250GB
	HDD	320GB
	HDD	640GB
	SSD	256GB

Table 2: List of Tested Drives

#### 3.2 TEST SYSTEM CONFIGURATIONS

System	Model Number	Processor	Memory (DRAM)	Operating System
MacBook 13"	MB467	2.4Ghz Intel Core i7	2x1GB 1066 DDR3	OS X v10.5.6 Leopard
MacBook Pro 15"	MB471	2.53Ghz Intel Core i7	2x2GB 1066 DDR3	
MacBook Pro 17"	ZOG5	2.93Ghz Intel Core i7	2x4GB 1066 DDR3	
Quad Core Mac Pro	MB871	2.66Ghz Intel Core i7	4x2GB 1066 DDR3	
8-Core Mac Pro	MB535	2x2.26Ghz Intel Core i7	8x2GB 1066 DDR3	

Table 3: Test System Configurations

#### 3.3 BENCHMARKING SOFTWARE

We used the following software to benchmark the Apple Mac disk performance.

- xBench v1.3

## 4.0 TEST RESULTS

### 4.1 13" MACBOOK

We tested the built in 250GB Hard Disk Drive and then upgraded to the 64GB UltraDrive ME, tested again and compared the results. After blessing the system we found the boot time cut by nearly 60% and the overall disk test score as measured by xBench improved by over 5x! On Random performance The UltraDrive delivered roughly 10x the performance of the Hard Disk and it showed up in the test scores. It was interesting to see that the built in HDD achieves less than 1MB/sec on the random 4K read and write tests. On 4K random reads the UltraDrive ME outperformed the HDD by over 25x.

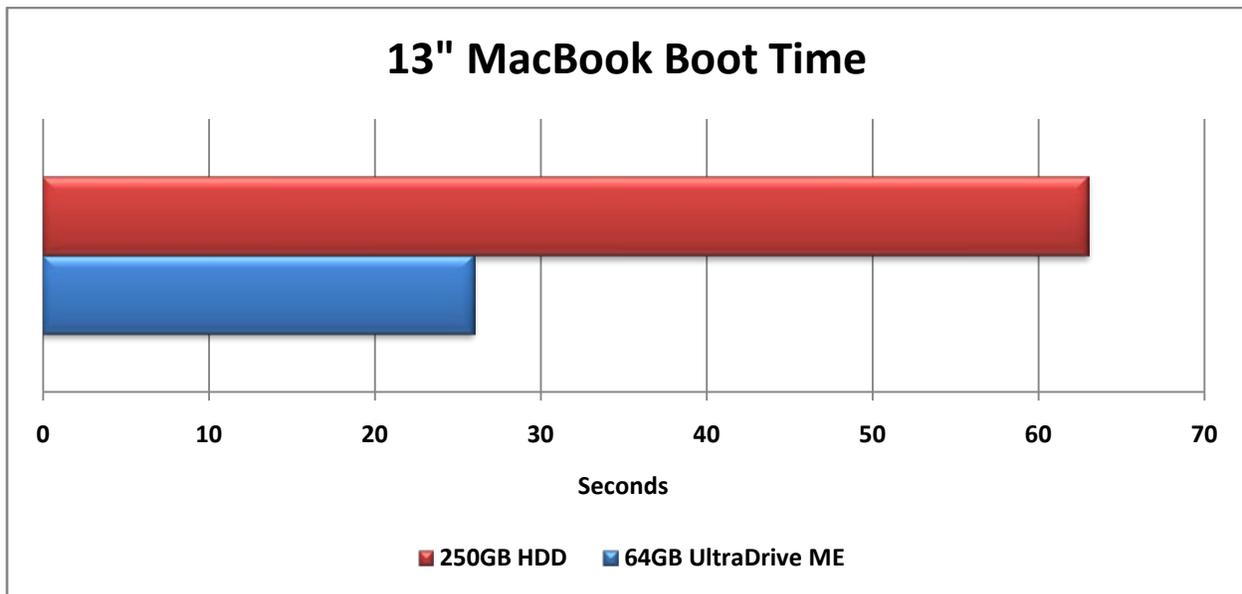


Figure 1: 13" MacBook Boot Performance

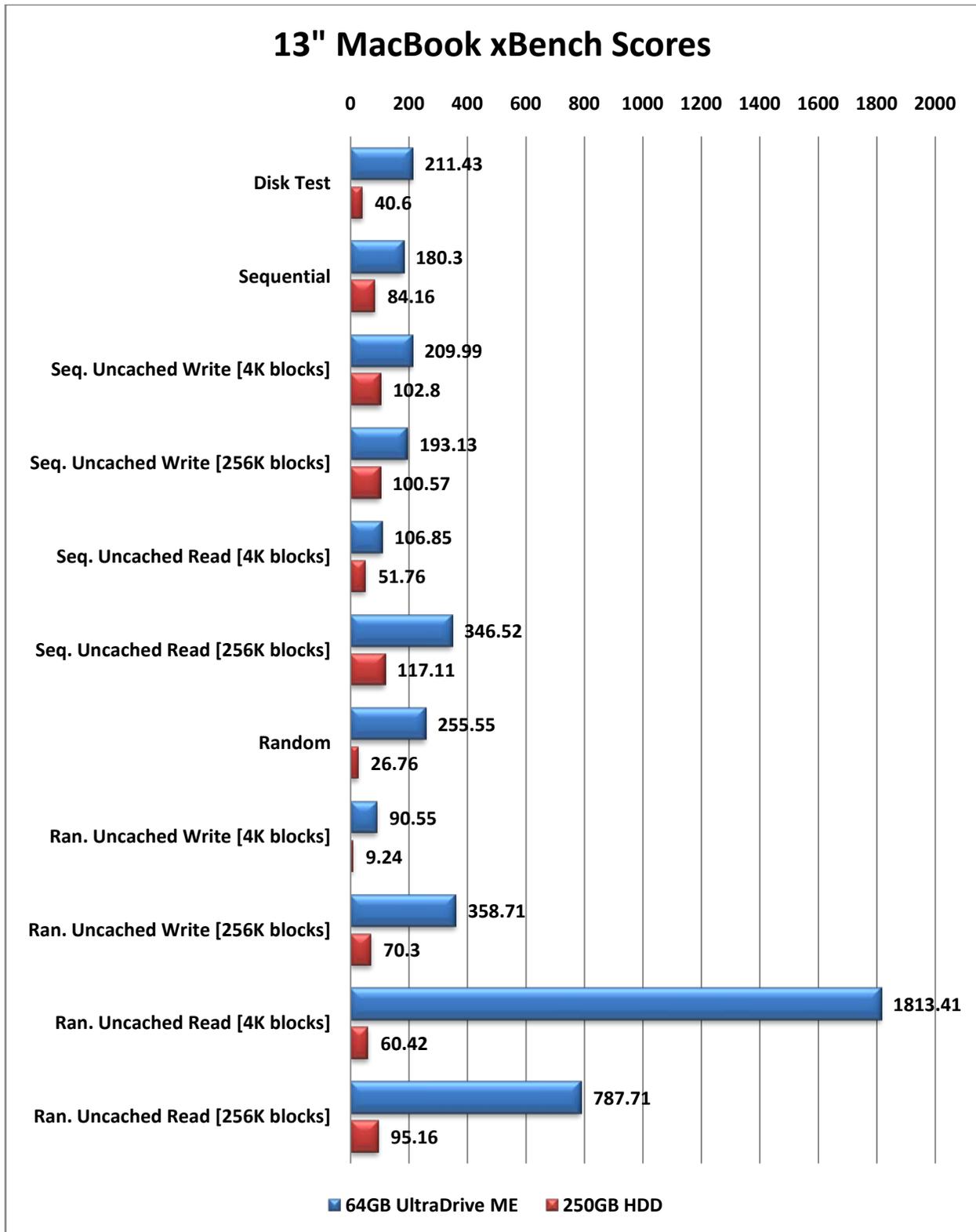


Figure 2: 13" MacBook xBench Scores

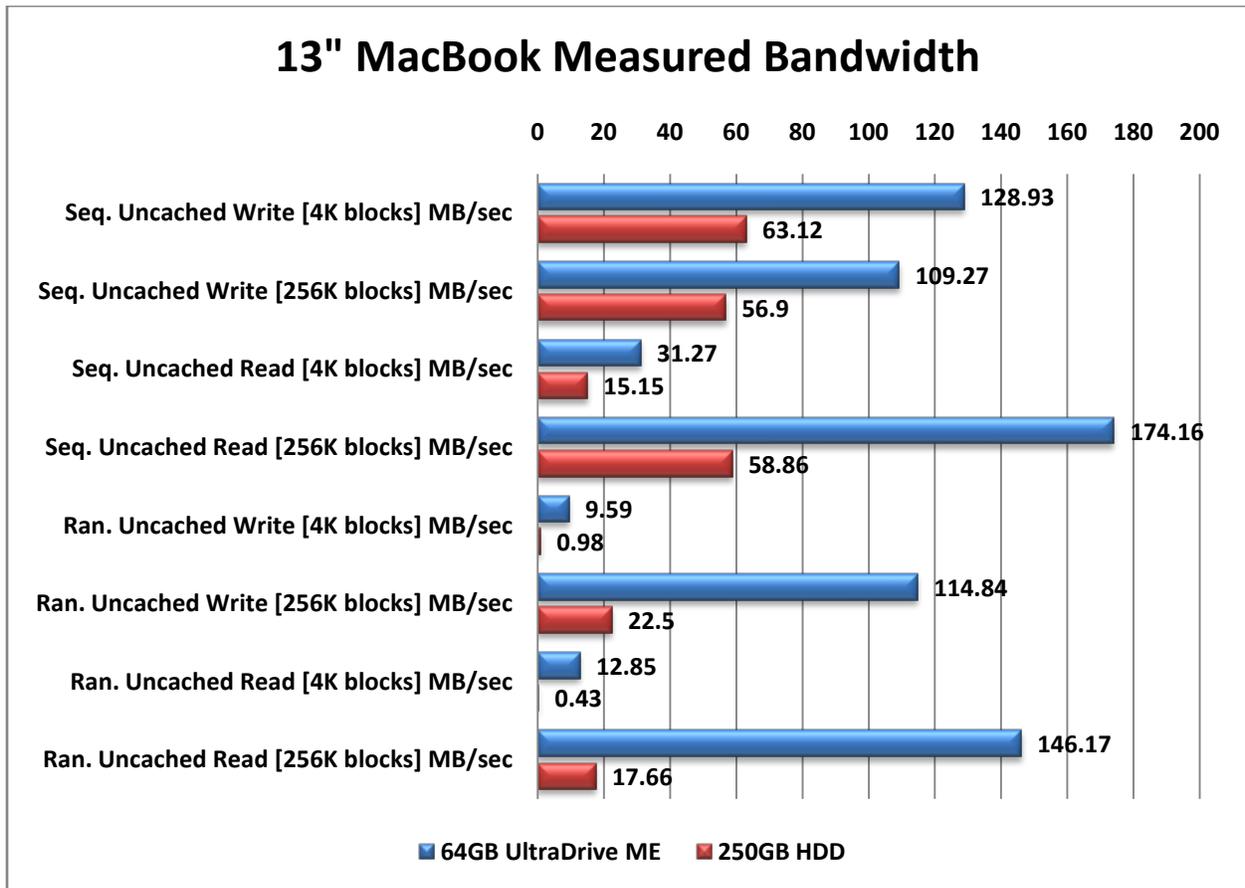


Figure 3: 13" MacBook Measured Bandwidth

## 4.2 MACBOOK PRO

We tested both the new 15" and 17" MacBook Pros with built in Intel Core i7 CPUs.

### 4.2.1 15" MACBOOK PRO

We compared the standard built in 320GB HDD to our 64GB UltraDrive ME. Boot time fell from 38 to 29 seconds. The difference in boot speed was noticeable. Note that the first time we installed the SSD the boot time actually went up to nearly 60 seconds. That's when we figured out we needed to bless the drive. That can be done by holding down the option key during boot and selecting the SSD. Then after the system boots up set it as your primary target drive using Disk Utility.

Then we ran xBench and observed a 5x increase in score vs. the HDD. On 4K Random Reads we saw over 32x the bandwidth on 256K Random Writes we saw over 4x the bandwidth.

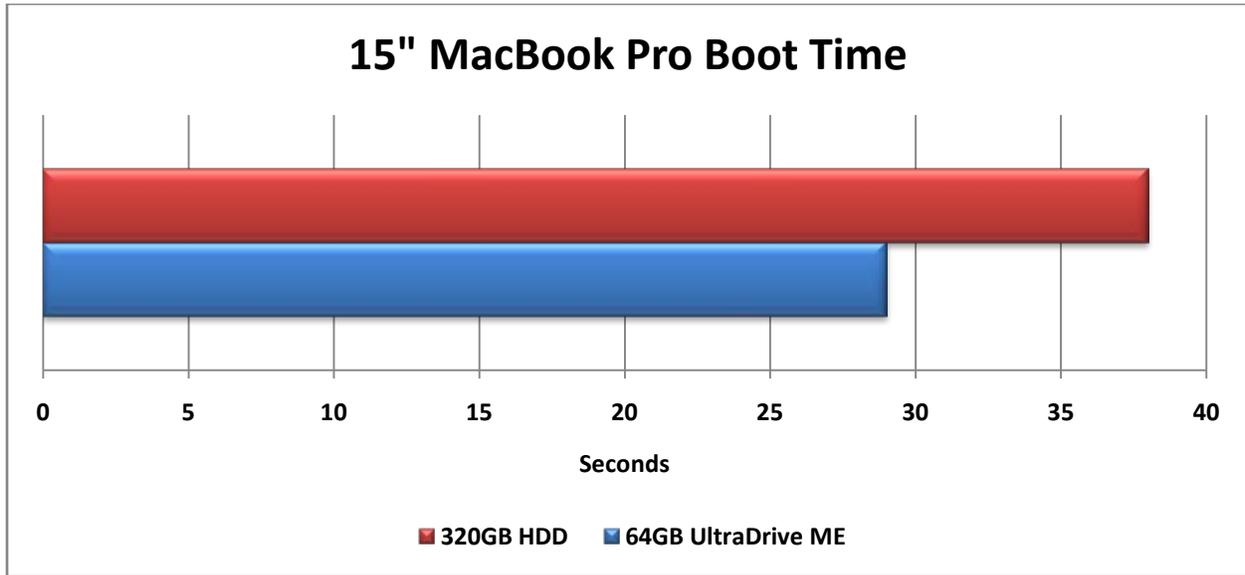


Figure 4: 15" MacBook Pro Boot Time

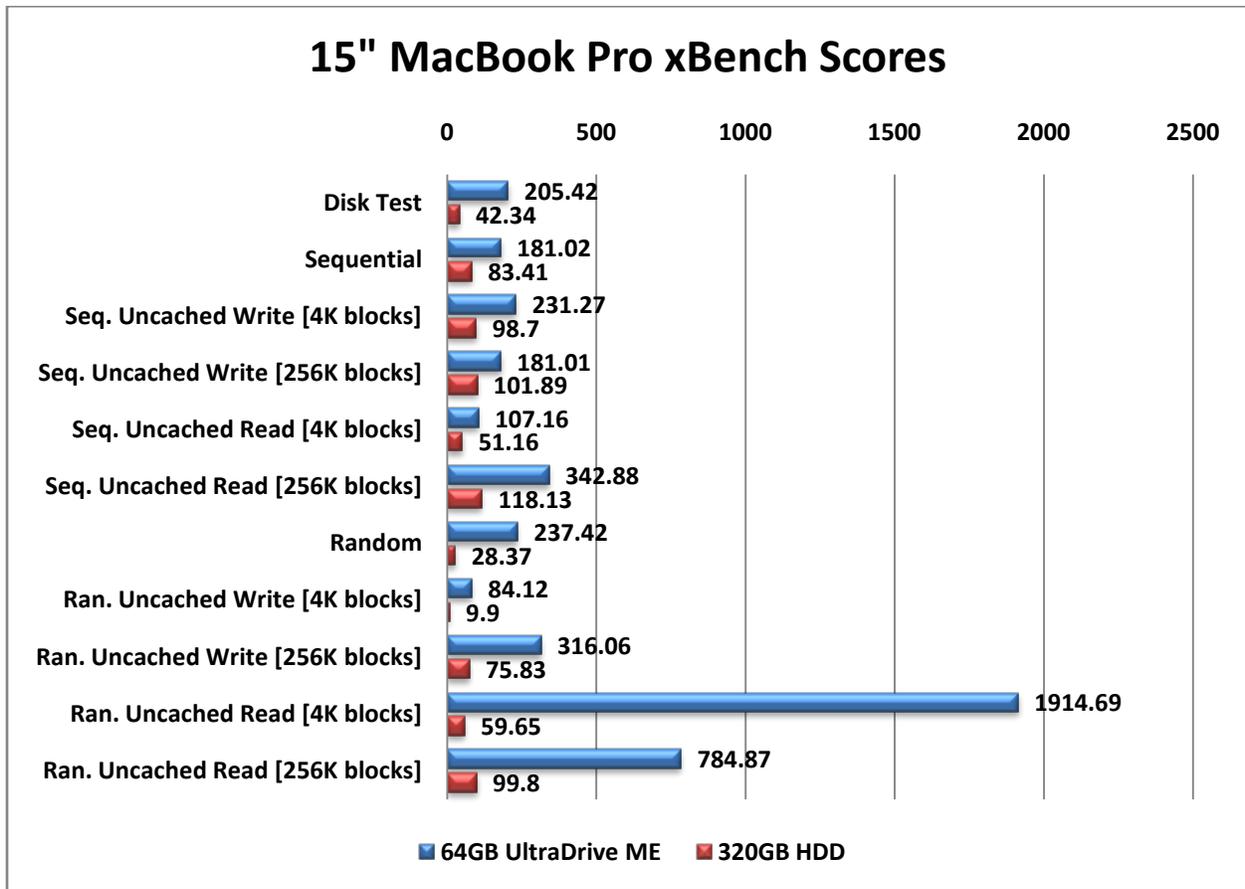


Figure 5: 15" MacBook Pro xBench Scores

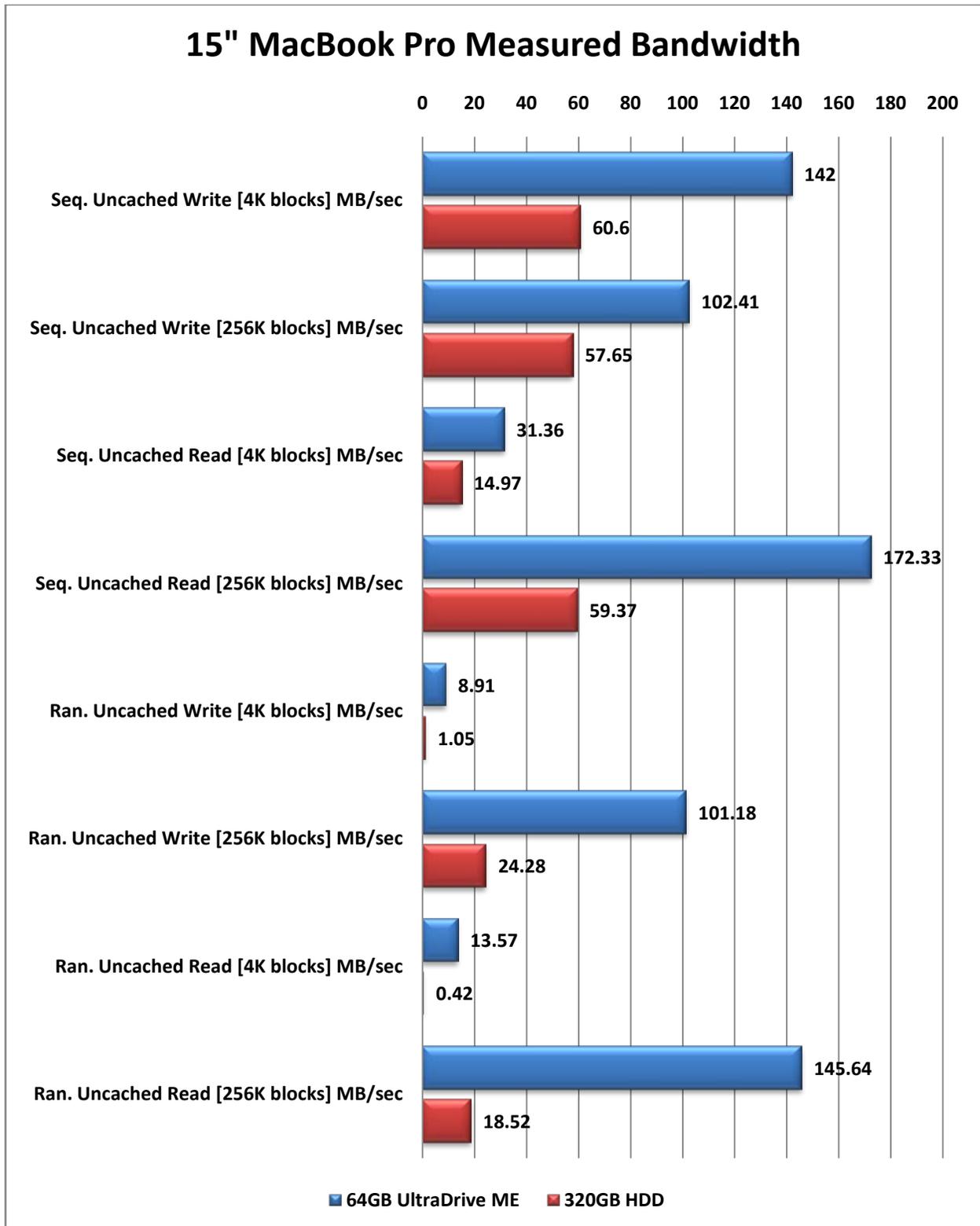


Figure 6: 15" MacBook Pro Measured Bandwidth

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### 4.2.2 17" MACBOOK PRO

Boot times improved from 38 seconds to 32 seconds when going from the Apple HDD to the Apple SSD. As shown in Figure 7: 17" MacBook Pro Boot Time boot times improved again to 28 and 27 seconds with the 64GB and 256GB UltraDrive ME respectively.

The Apple SSD showed great gains over the Apple HDD achieving approximately 2x the overall xBench disk score. But the 64GB UltraDrive ME achieved ~4.5x the overall score and the 256GB UltraDrive ME achieved ~5.4x the overall score significantly outperforming the Apple SSD. See Figure 8: 17" MacBook Pro xBench Scores for more details.

Both the 64GB and 256GB Super Talent UltraDrive ME SSDs achieved 90% greater bandwidth on every single test compared to the Apple SSD. See Figure 9: 17" MacBook Pro Measured Bandwidth for more details.

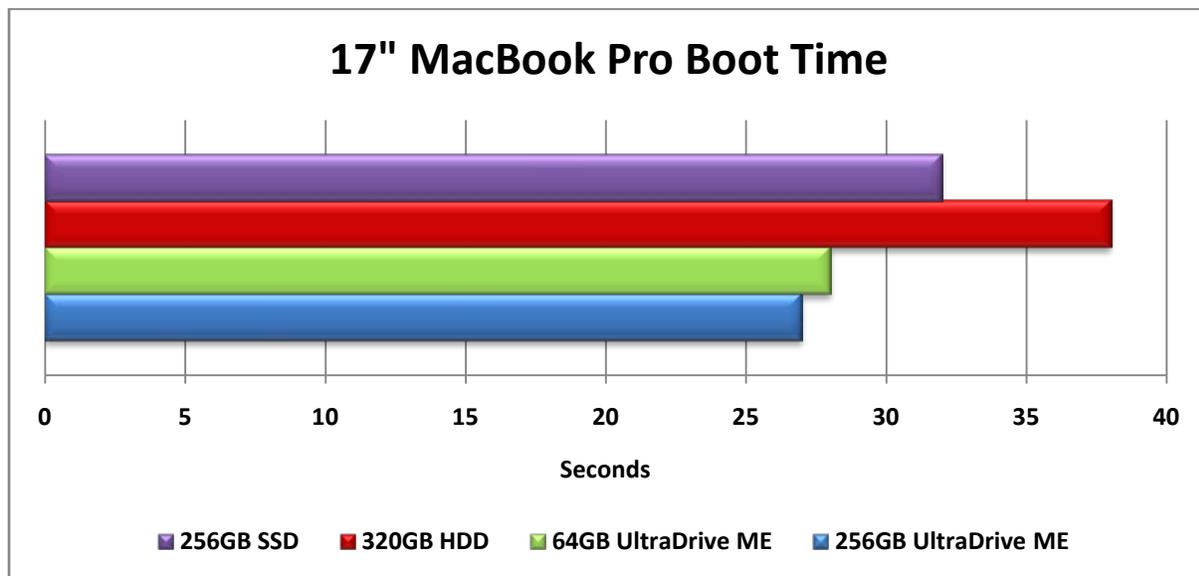


Figure 7: 17" MacBook Pro Boot Time

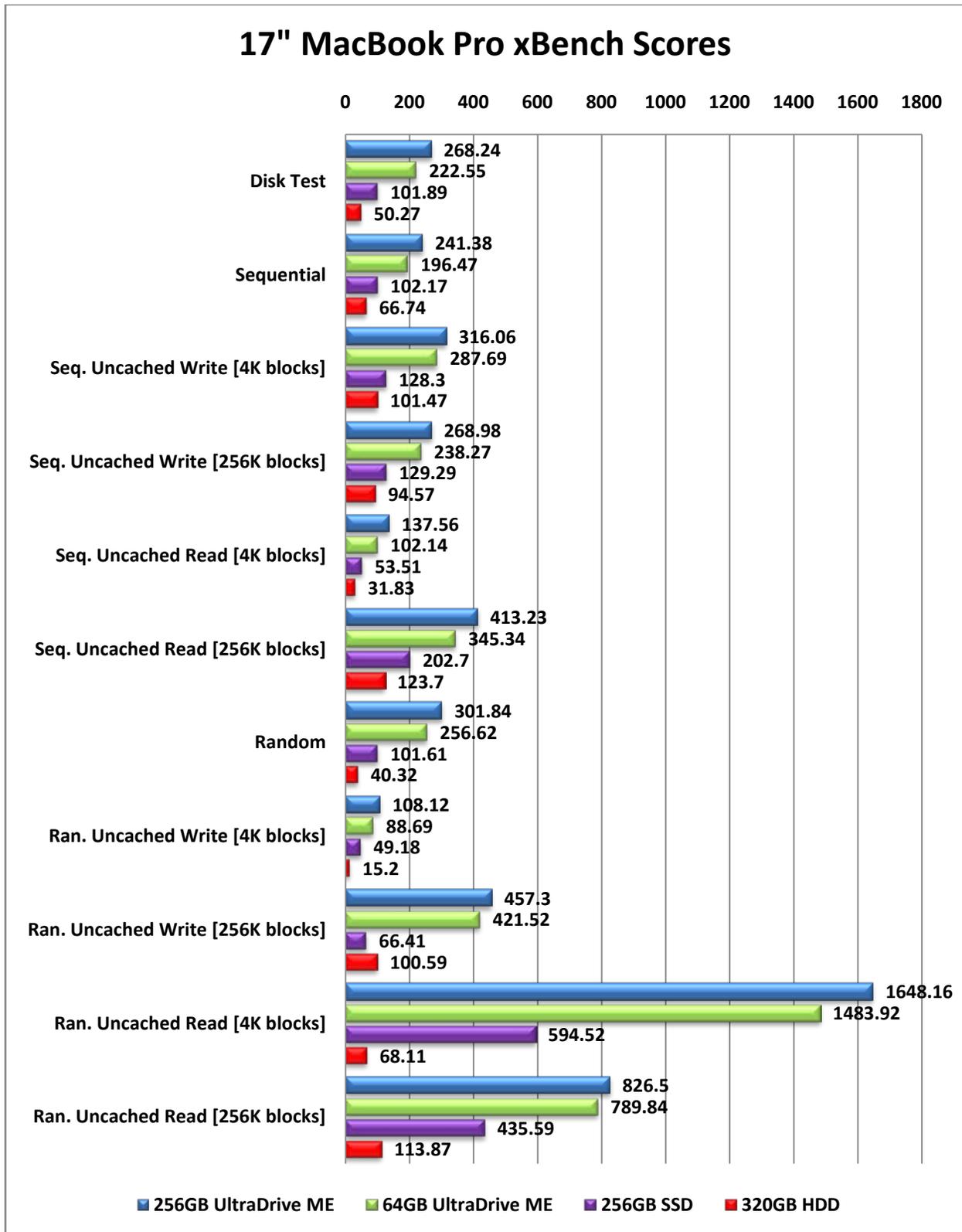


Figure 8: 17" MacBook Pro xBench Scores

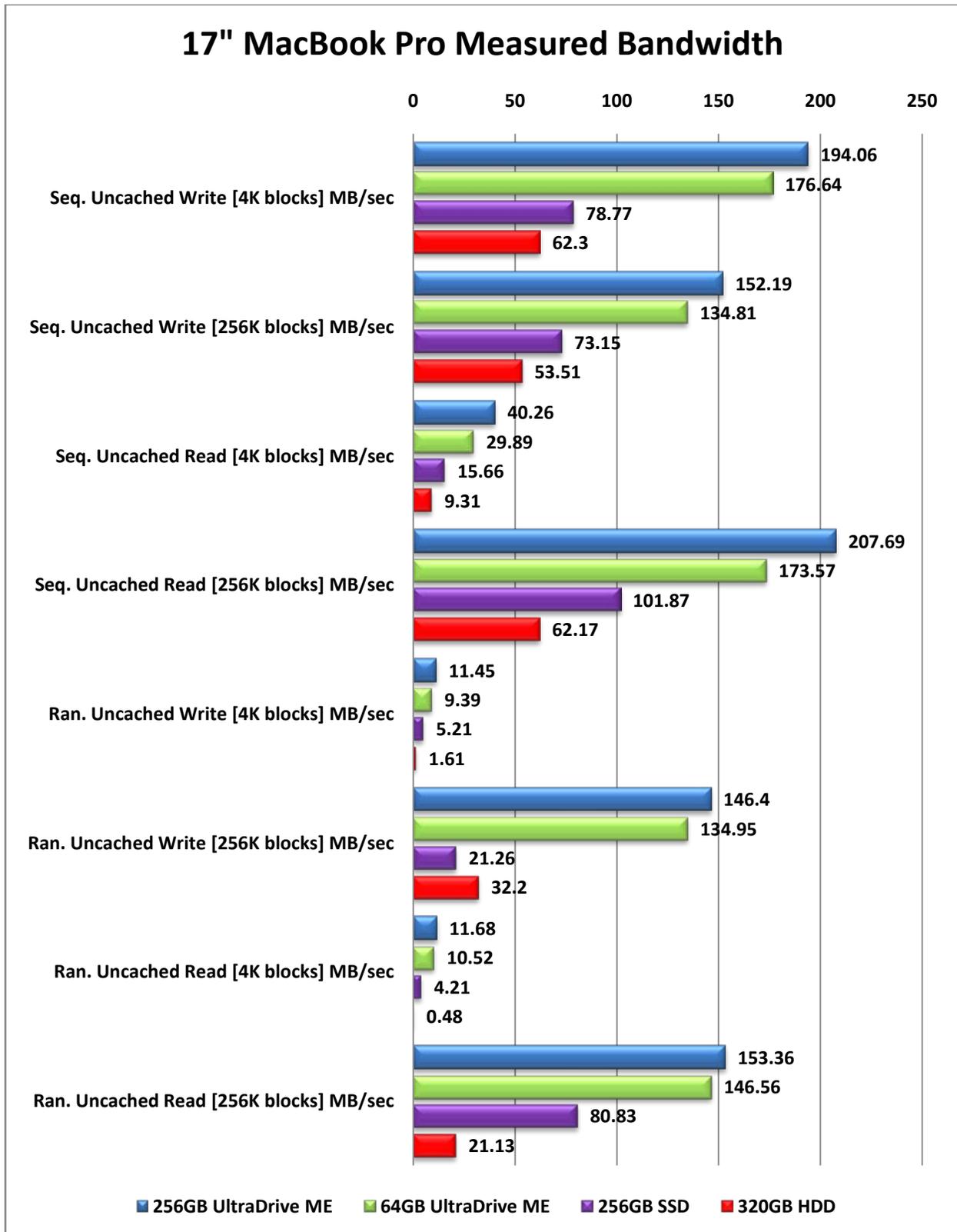


Figure 9: 17" MacBook Pro Measured Bandwidth

#### 4.3 MAC PRO

The new Mac Pro comes standard with 4 SATA Ports. The built in controller supports RAID0, RAID1 and JBOD. The built in Disk Utility Software allows the user to create RAID1 with stripe sizes of 16, 32, 64, 128 and 256 KB. We did the majority of our testing on the Quad Core Mac Pro.

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##### 4.3.1 MAC PRO QUAD CORE RAID STRIPING PERFORMANCE

First we took the Quad Core Mac Pro and ran it with its built in 640GB HDD as the boot drive and three of our 32GB UltraDrive LE drives in RAID1 on SATA ports 2-4. We ran the benchmark repeatedly as we swept the stripe size of the RAID1 array from 16KB to 256KB. The results are in Figure 10: Mac Pro UltraDrive LE Stripe Test xBench Scores and Figure 11: Mac Pro UltraDrive LE Stripe Test Measured Bandwidth. The 256KB stripe scored tops but some of that may be due to the test weighing 256KB transactions so highly. In all there was relatively little difference in performance between stripe sizes.

Next we wanted to see how performance varied with stripe size with MLC Flash on the UltraDrive ME, but we were short on time and we saw the best performance at 16KB, 64KB, and 256KB so we limited our test to these stripe sizes. Again the 256KB stripe RAID0 array came out on top with limited difference in performance between stripe sizes. Full details are in Figure 12: Mac Pro 64GB UltraDrive ME Stripe Test xBench Scores and Figure 13: Mac Pro 64GB UltraDrive ME Stripe Test Measured Bandwidth below.

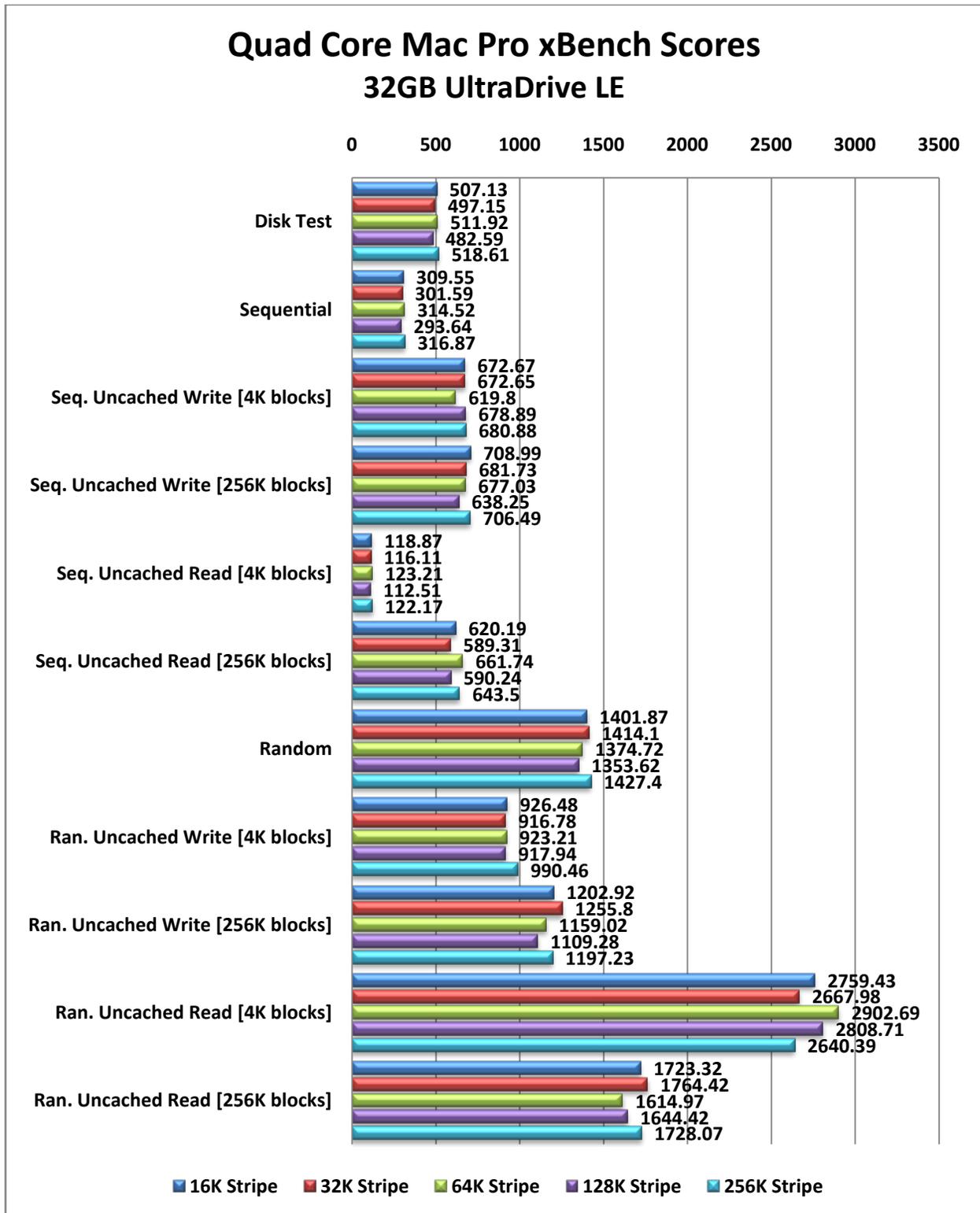


Figure 10: Mac Pro 32GB UltraDrive LE Stripe Test xBench Scores



Figure 11: Mac Pro 32GB UltraDrive LE Stripe Test Measured Bandwidth

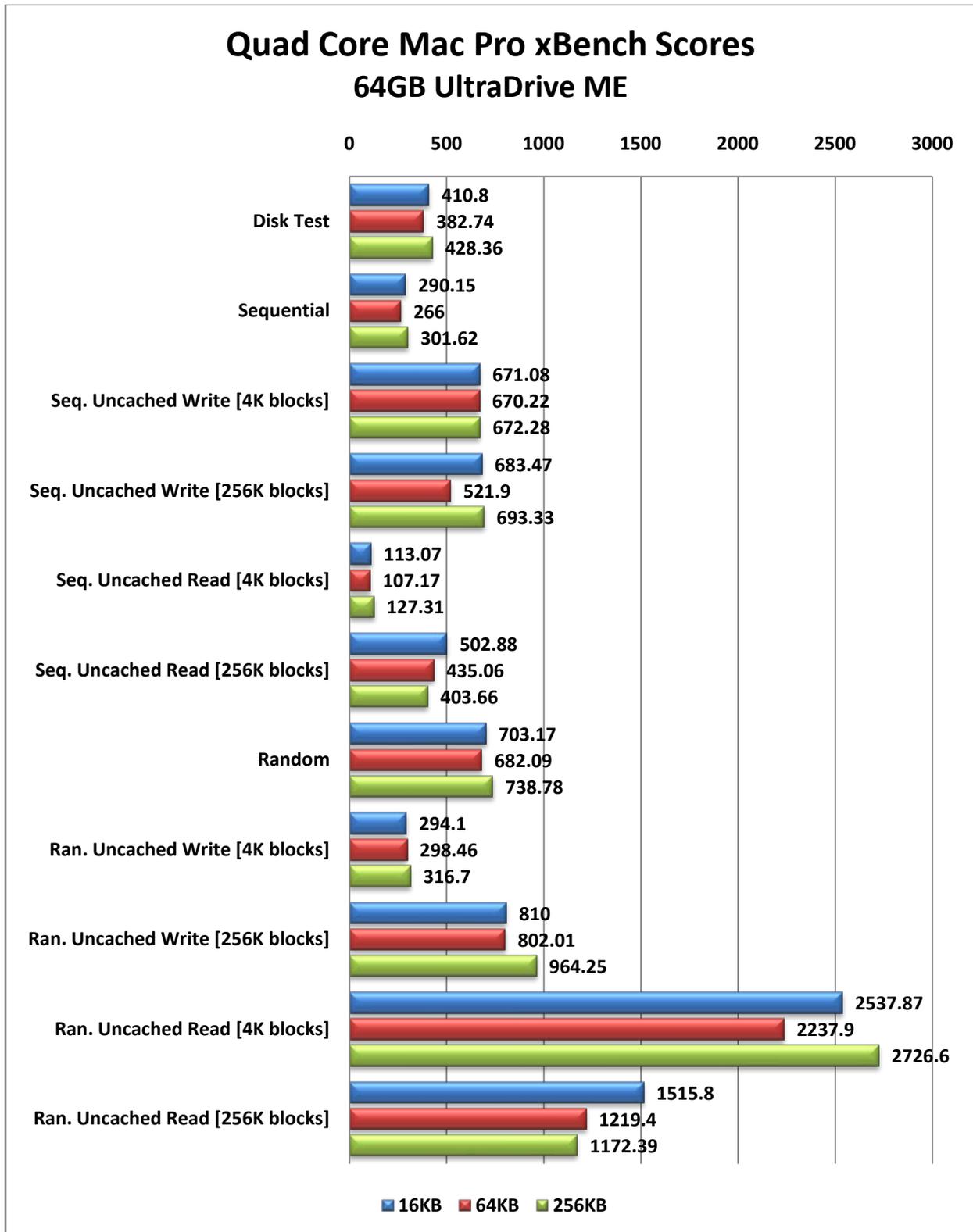


Figure 12: Mac Pro 64GB UltraDrive ME Stripe Test xBench Scores

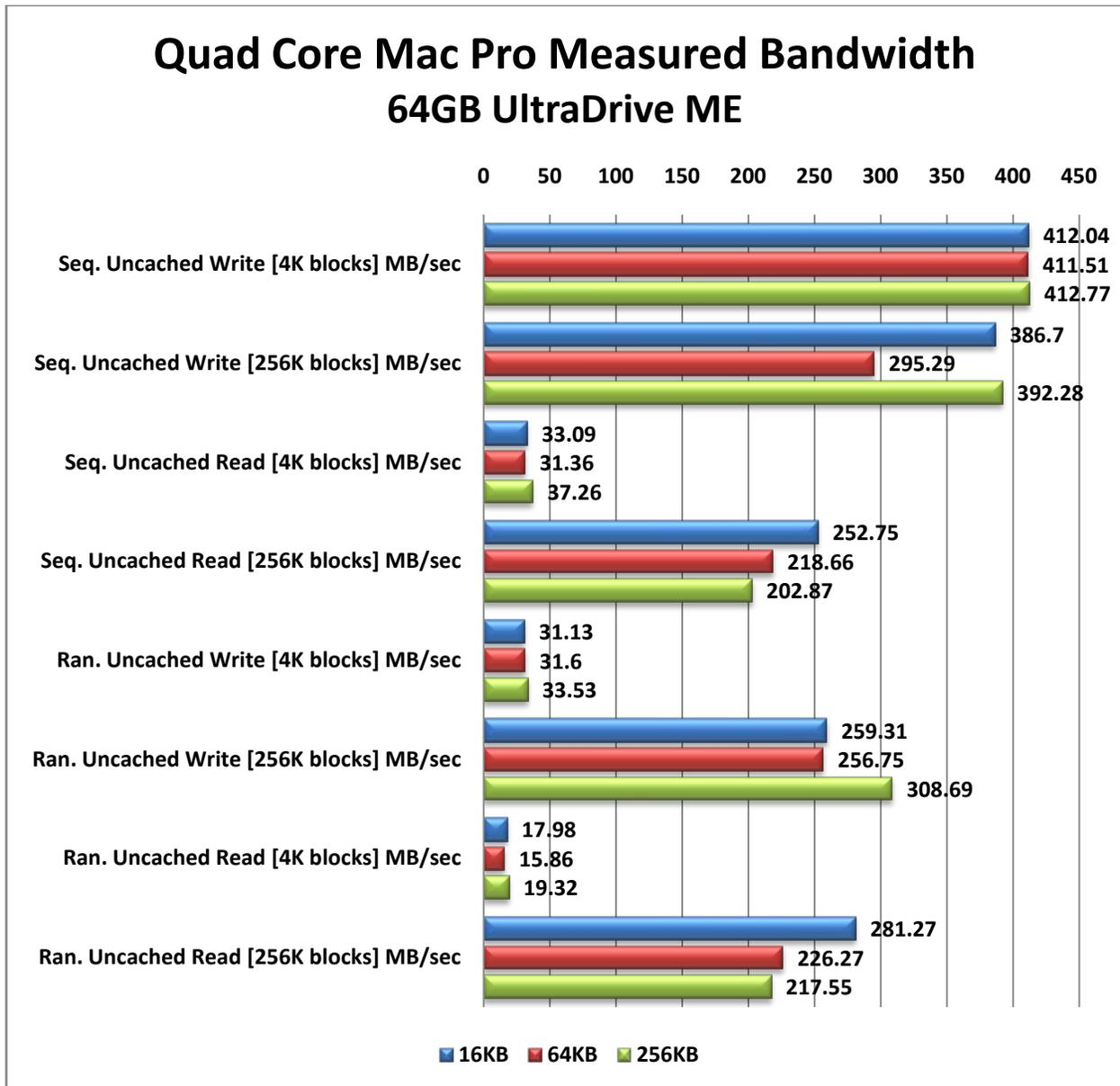


Figure 13: Mac Pro 64GB UltraDrive ME Stripe Test Measured Bandwidth

#### 4.3.2 MAC PRO RAID0 BOOT DRIVE VS. SECONDARY DRIVE

We were curious how much of a performance hit we would see running xBench on our RAID array when we were also running our Operating System off of the array. We ran 3 of the 32GB UltraDrive LE in RAID0 with 256KB stripe sizes (since we saw the best overall benchmark score with that striping), and tested with the array configured as our boot drive containing our OS and also as a secondary drive. The results are below in Figure 14: Mac Pro Boot vs. Secondary Drive xBench Scores and Figure 15: Mac Pro Boot vs. Secondary Drive Measured Bandwidth.

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Interestingly random speeds were barely impacted or even better on the boot drive but sequential bandwidth was 3% to 15% worse on the boot drive than the secondary drive. Likely this is because of random reads and writes from the OS being issued during the sequential tests throwing the results off slightly. However this is a realistic measure of real life behavior.

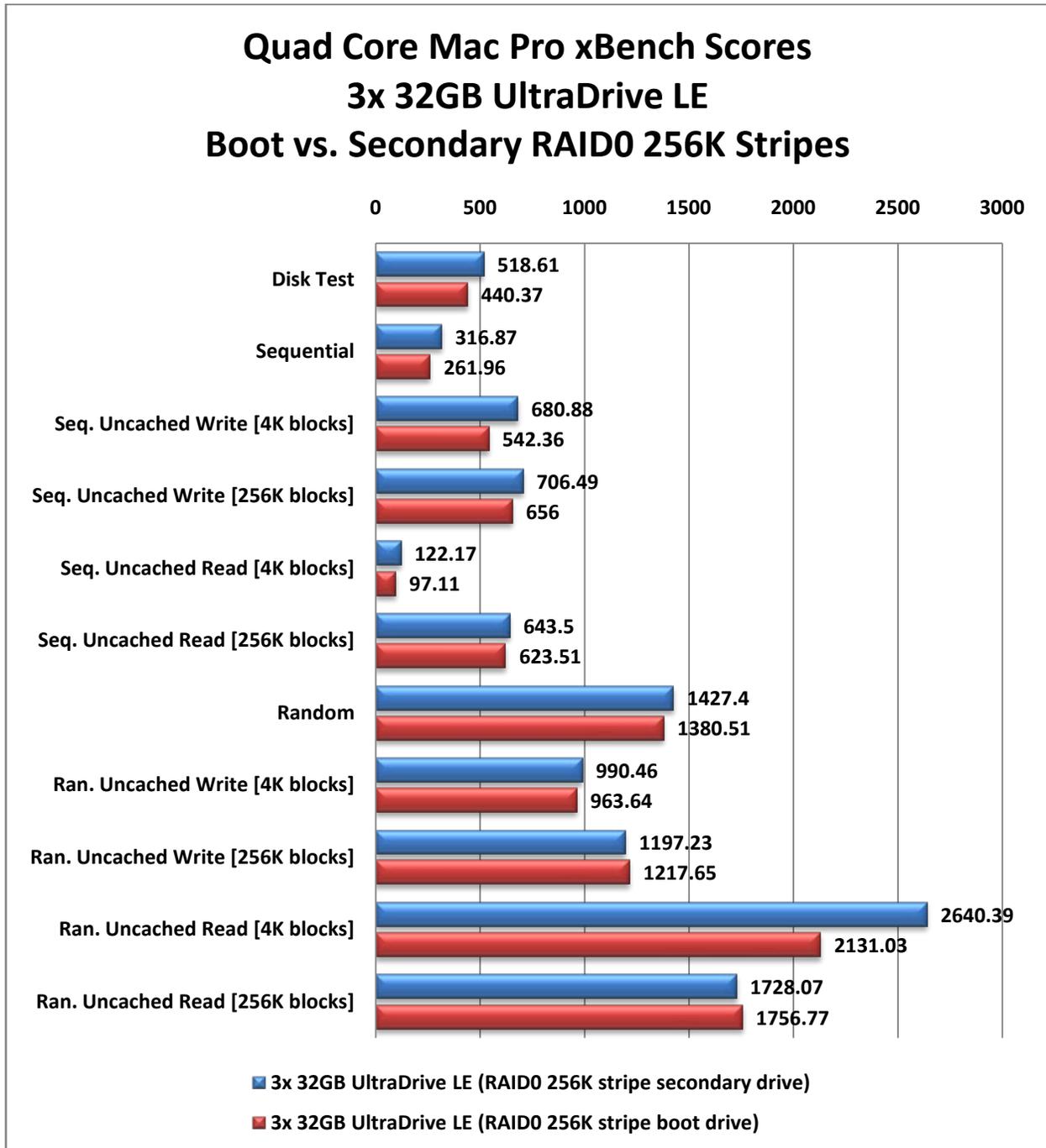


Figure 14: Mac Pro Boot vs. Secondary Drive xBench Scores

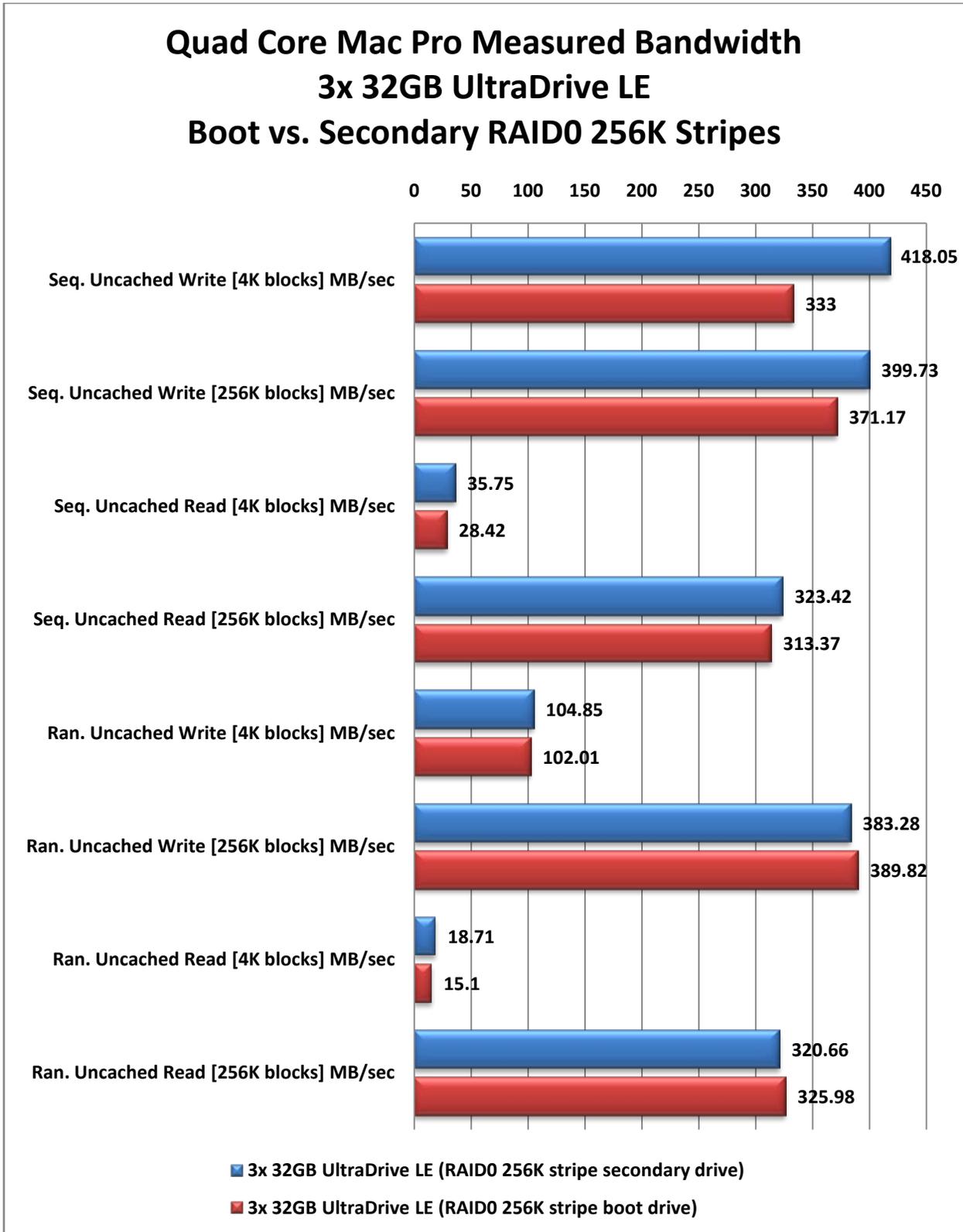


Figure 15: Mac Pro Boot vs. Secondary Drive Measured Bandwidth

4.3.3 MAC PRO RAID0, RAID1, AND JBOD

Figure 16: Mac Pro RAID0, RAID1, & JBOD xBench Scores and Figure 17: Mac Pro RAID0, RAID1, & JBOD Measured Bandwidth compare the performance of 3 units of 32GB UltraDrive LE in RAID0 with 256KB stripes, RAID1 and JBOD. As expected the RAID0 significantly outperformed the other arrays. Interestingly small sequential reads didn't benefit from the RAID0 structure.

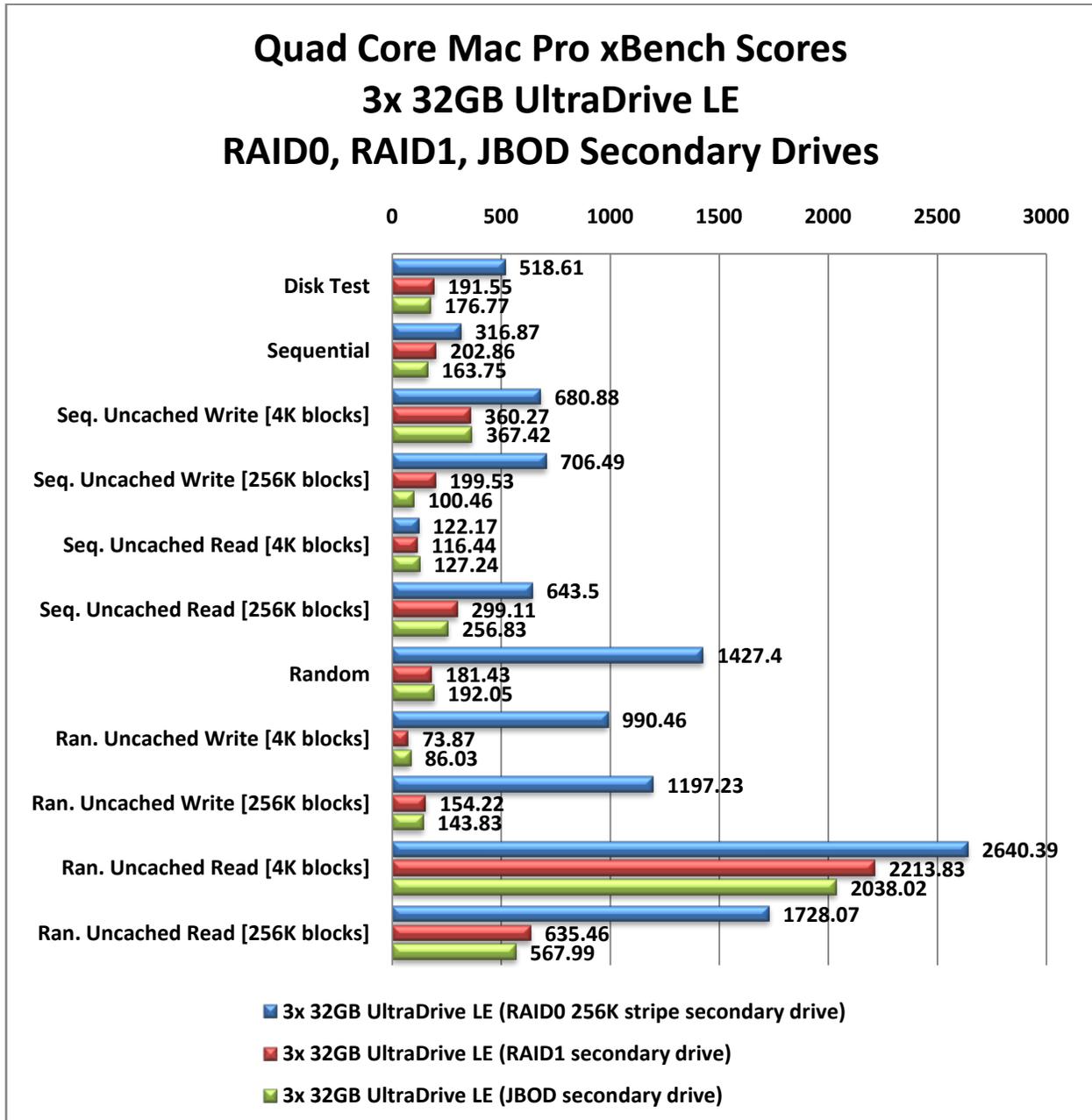


Figure 16: Mac Pro RAID0, RAID1, & JBOD xBench Scores

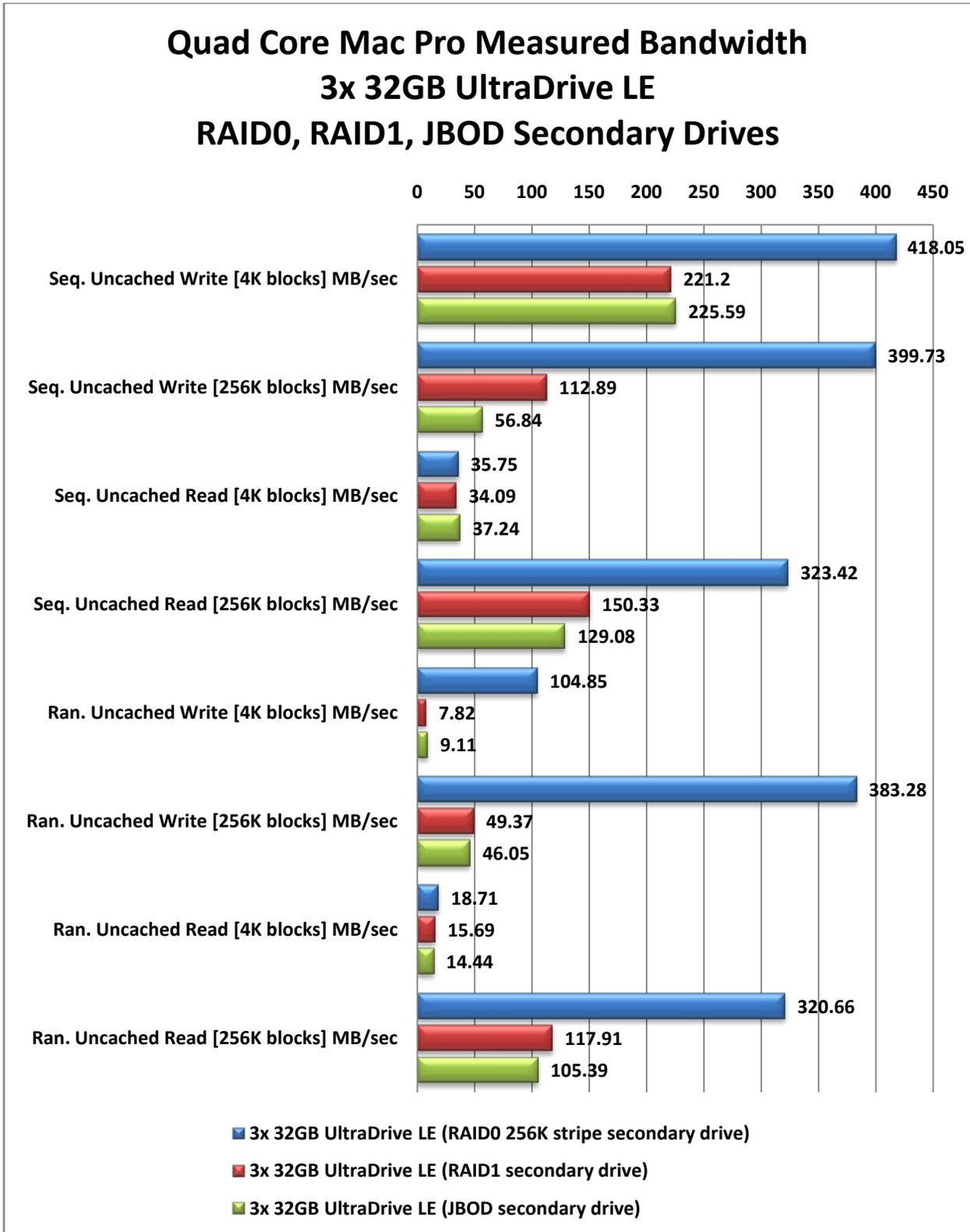


Figure 17: Mac Pro RAID0, RAID1, & JBOD Measured Bandwidth

#### 4.3.4 MAC PRO ULTRADRIVE LE VS. ULTRADRIVE ME PERFORMANCE IN RAID0

Finally we go head to head with the 32GB UltraDrive LE and the 64GB UltraDrive ME. This is an interesting match-up because both devices have the same number of Flash die and the same number of pages. The results of our testing are below in Figure 18: Mac Pro LE vs. ME RAID0 xBench Scores and Figure 19: Mac Pro LE vs. ME RAID0 Measured Bandwidth.

In the end both drives achieved nearly 420 MB/sec write speeds which is fast enough to capture three unencrypted HD Video streams. As expected the SLC UltraDrive LE outperformed the MLC UltraDrive ME slightly, but more significantly in 4KB random writes 990 to 316. Still when comparing to the built in HDD's unimpressive 19, as shown in Figure 20: 8-Core Mac Pro HDD xBench Scores, one can see how easy it is to reap the performance benefits of SSD technology with lower cost MLC based products.

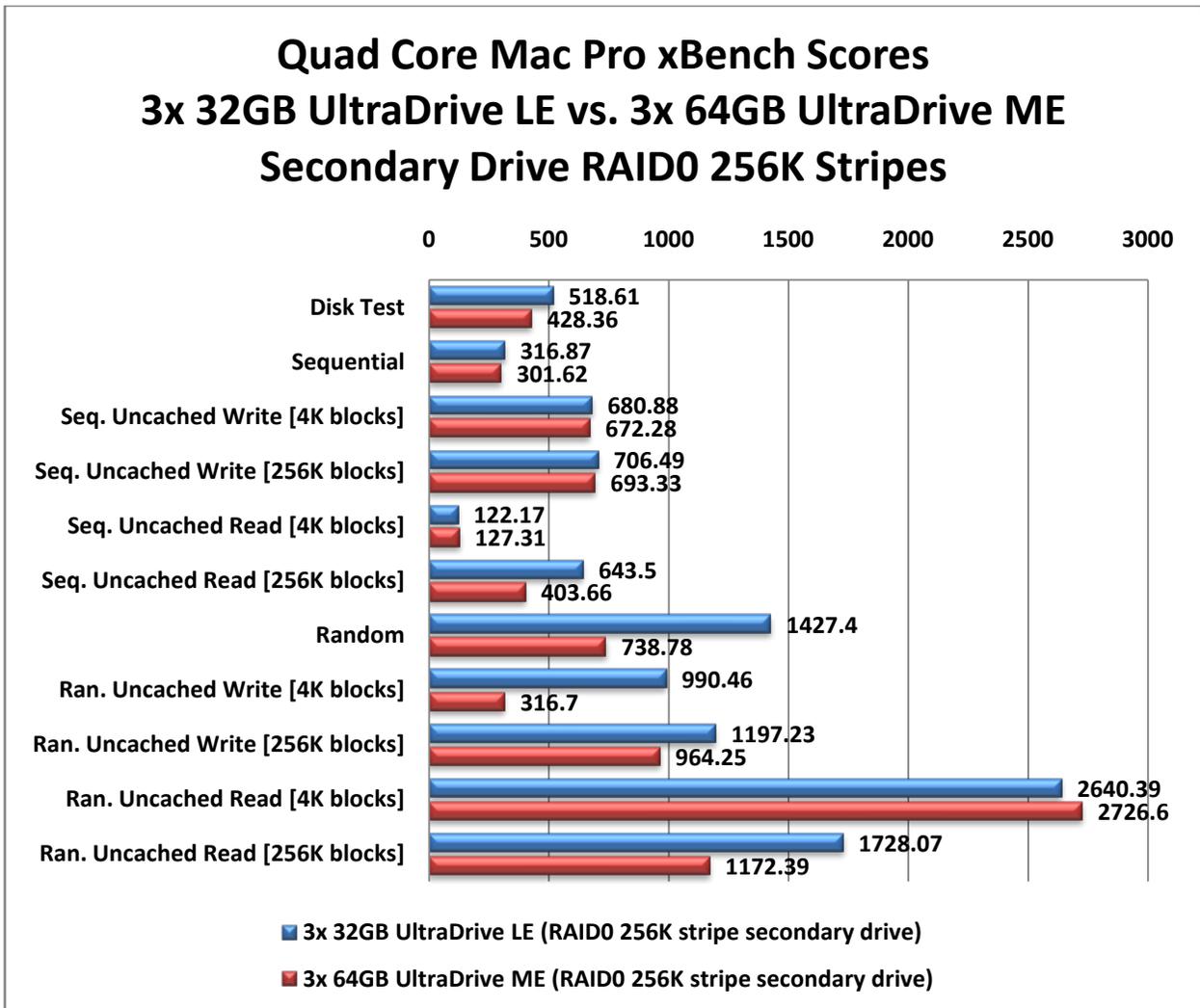


Figure 18: Mac Pro LE vs. ME RAID0 xBench Scores

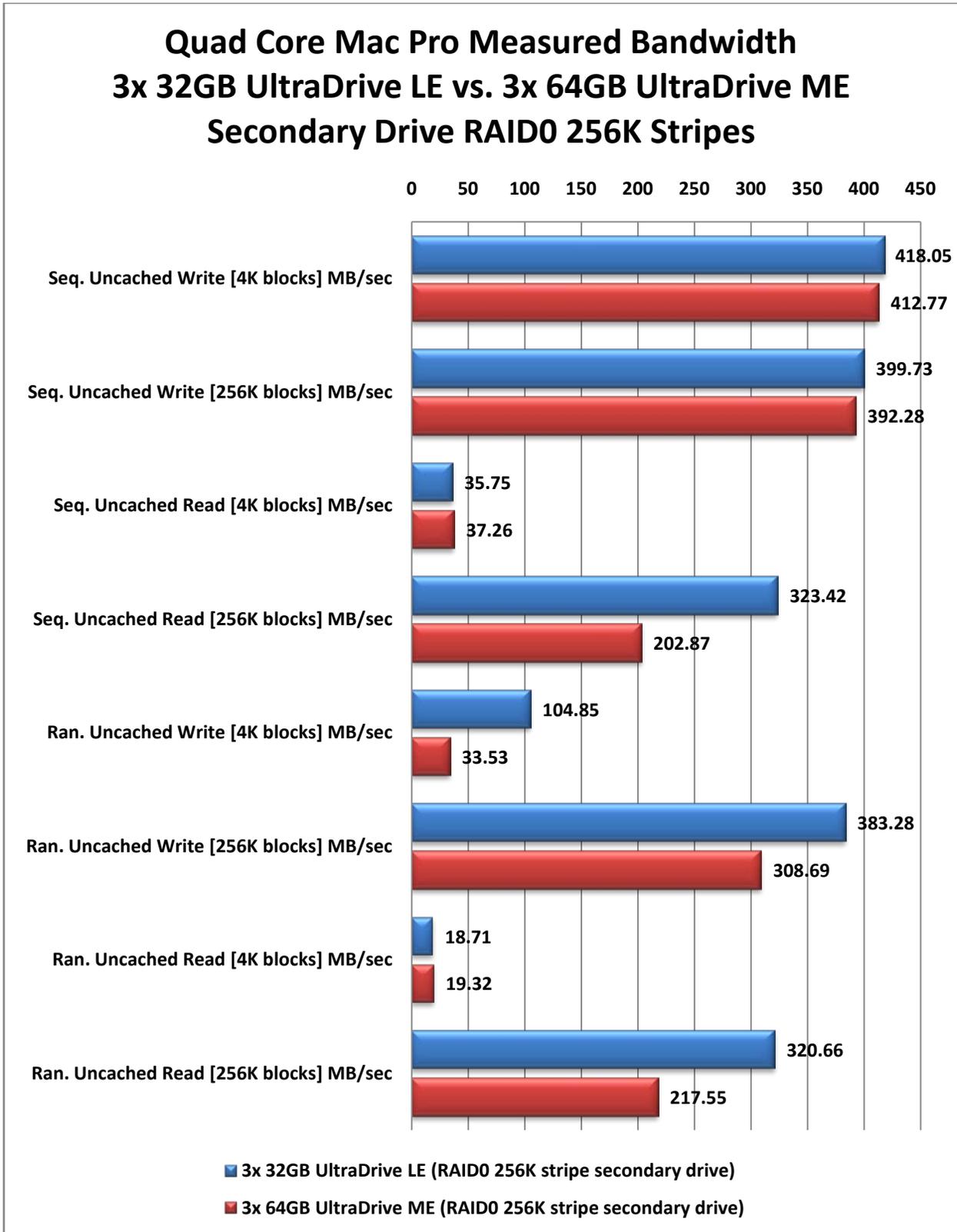


Figure 19: Mac Pro LE vs. ME RAID0 Measured Bandwidth

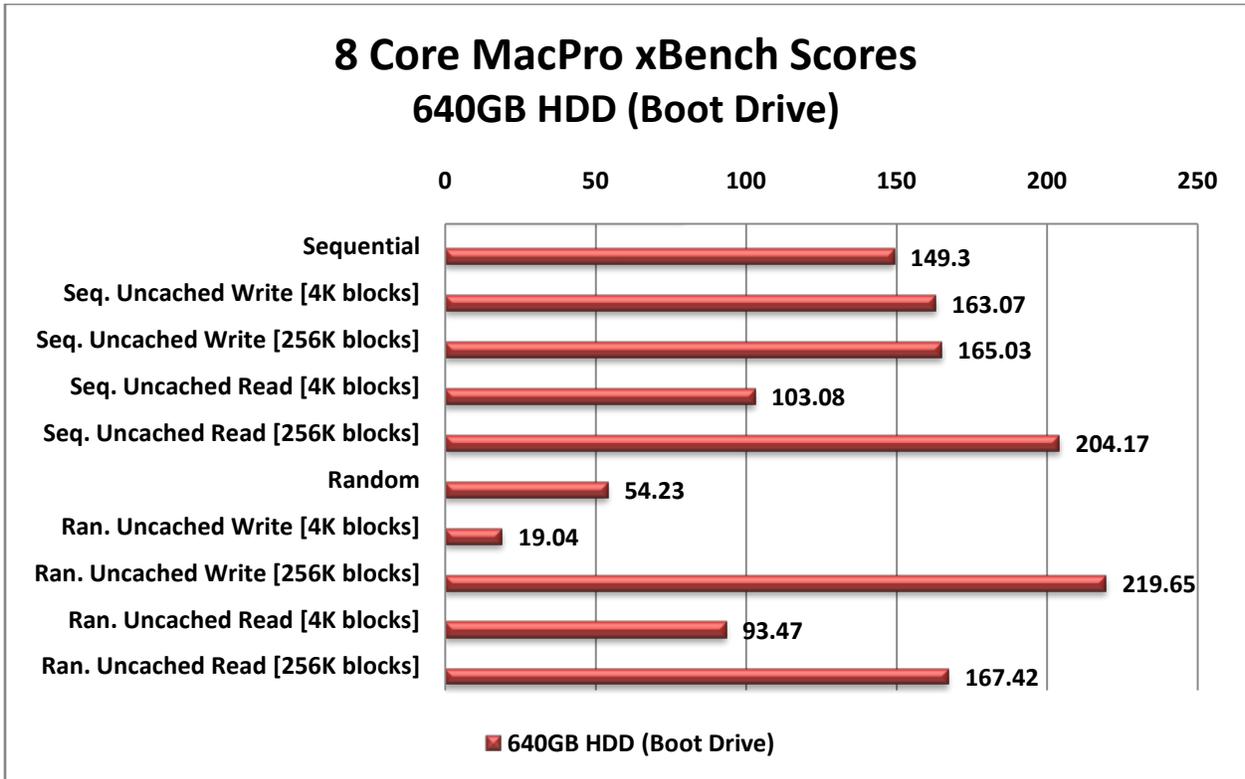


Figure 20: 8-Core Mac Pro HDD xBench Scores

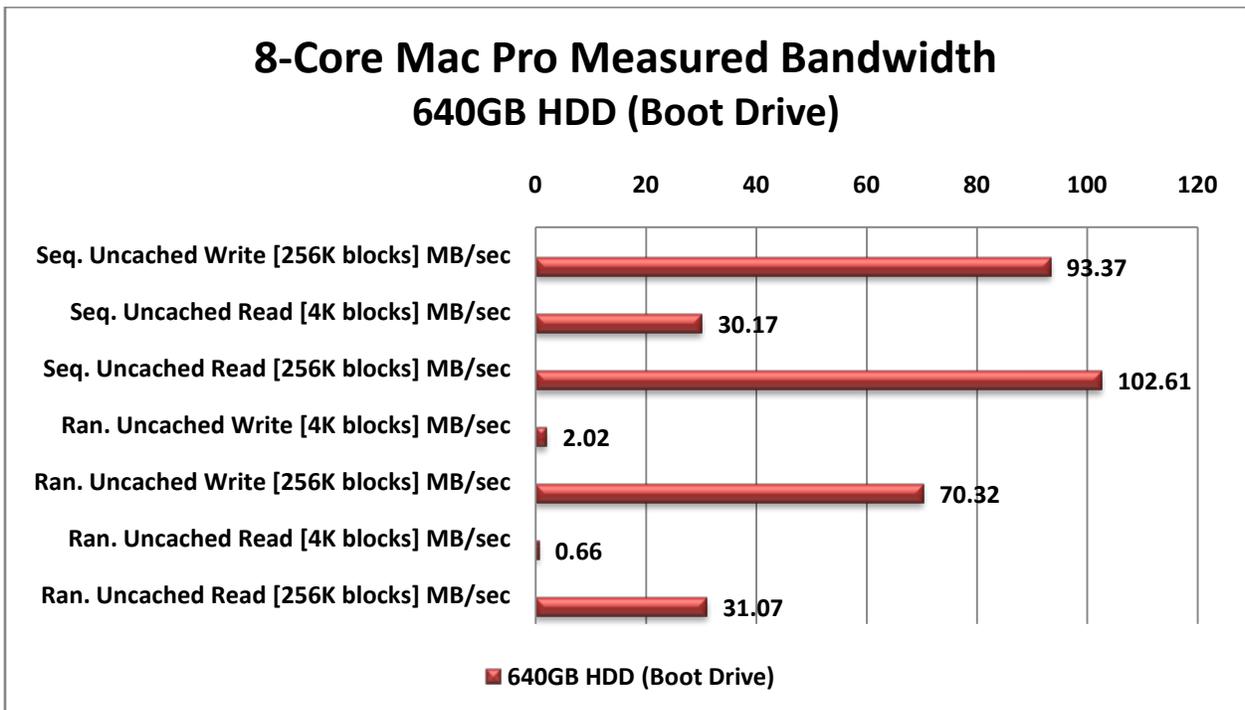


Figure 21: 8-Core Mac Pro HDD Measured Bandwidth

## 5.0 CONCLUSION

The UltraDrive delivers consistent performance 4 to 5 times that found on a standard Apple HDD and 2 to 3 times that found on a standard Apple SSD. This performance shows up in real world applications such as boot time where the UltraDrive delivers up to 60% shorter boot times vs. the stock HDD.

The UltraDrive is easy and quick to install in the new MacBook and MacBook Pros. Disk Utility makes the copy over process simple even for non-“Geniuses” and users will reap significant performance gains by upgrading to a Super Talent SSD.

The UltraDrive can be used in RAID1, RAID0 and JBOD configurations to deliver unheard of performance in the MacPro. For under \$500 a user can create an internal disk array capable of delivering over 400MB/sec performance!

## FOR MORE INFORMATION

Please Contact:

Super Talent Technology  
2077 North Capitol Avenue  
San Jose, CA 95132  
USA  
Tel: +1 (408) 934-2560  
Support: [Support@supertalent.com](mailto:Support@supertalent.com)  
Sales: [Sales@supertalent.com](mailto:Sales@supertalent.com)  
OEM Sales: [OEMSales@supertalent.com](mailto:OEMSales@supertalent.com)