THE CUSTOMER: CROWLEY MARITIME CORPORATION

Our company, Crowley Maritime Corporation (CMC), was ready for a DASD acquisition. CMC’s holding companies comprise the world’s largest diversified maritime services organization. DASD acquisition was almost an annual event in that the strategy was to keep three generations of storage on the floor and rotate out the oldest generation with the next DASD purchase.

In normal buying years, a DASD purchase would be based on the DASD moving out with the expiring leases (plus anticipated growth). Last year, we had two second generation leases expiring, and our third generation leases were going off the books soon after. This represented 80 percent of our DASD capacity, which was definitely at its limit (actually, we were in latent demand mode, i.e., we needed more DASD now).

Our buying methodology consisted of the following phases:

- **Vendor Selection:** Review the marketplace and select a list of vendors and their associated products.
- **Data Collection:** Work with each of the vendors, explain our needs, and gather whatever information they needed to do their analysis.
- **Vendor Presentation:** Like a trial, each vendor would present its case.
- **Appraisal:** Each vendor would be apprised of its status, including the “knock-offs” brought up by competing vendors.
- **Rebuttal:** Each vendor would be given the opportunity to make a final presentation.
- **Selection:** Selection(s) would be made, including acceptable alternatives, and presented to I/S management. The final selection would be based on our business needs.

From our perspective, the determining factors are RAS (reliability, availability, and serviceability), as well as performance, functionality, and cost. Not included, but assumed, is the vendor relationship.

The baseline for our selection was the Hitachi Data Systems HDS 7690-3 controller with 128 MB of cache and ESCON channels. This is comparable to IBM’s 3990-6 controller. The DASD was the equivalent of IBM’s 3390-2s and 3390-3s. We would focus on how the DASD could handle DB2 sequential prefetches, a phenomenon in which DB2 requests large blocks of data. This exercised the DASD in a unique way. The instance of a single DASD I/O of this type is strictly dependent on how fast data can be moved from the platter to the host. This meant that this I/O’s response time is only as fast as the slowest link in the path.

**VENDOR SELECTION**

In previous years, the number of vendor candidates was limited. IBM owned the DASD market and we had a strong relationship with HDS (hence two vendors). But, the marketplace has changed. STK’s (Storage Technology) “ICEBERG” has arrived. EMC, with its Symmetrix 5500, has gained significant market share. IBM would be making a bid with its RAID RAMAC II storage system. We initially ruled out HDS as a contender because its 7690-3 was considered “old” technology. However, HDS was added to the list when its new RAID DASD, the HDS 7700, went GA (general availability).

In addition, a well-respected marketing representative from one of our primary vendors joined a company new to the DASD area. He asked us to be a West Coast beta site for his company’s RAID-1 DASD. Since we were beyond our capacity limits, we accepted the offer.

*Please note: the above paragraph describes a marketing technique. It essentially said, “Bring in our box and try it for 90 days. If you don’t*
like it, take it out.” In most cases, the “try-it-you’ll like it” technique results in a permanent acquisition. Hence the following rule of thumb:

ROT: Don’t do a “try it, see if you like it” unless you already have decided on the acquisition.

As I mentioned previously, we are a small I/S shop. A few people normally handle our selection process. After the selection has been made, it would be discussed with upper management. This would be followed by more negotiations with the vendor(s). Then, a CER (capital expenditure request) is written requesting the product’s purchase. If the CER is consistent with our budget, it would normally be approved and the acquisition would be made.

My manager, Joe Mueller, and I managed the evaluation process in the product selection phase. I have more than 25 years of experience with IBM and large systems, and Joe has almost the same number of years with Crowley Maritime in large systems and storage administration. Still, we felt that using outside consultants was essential to help us put vendor information in perspective. A site visit by Meta Group and conference calls with the Gartner Group were very helpful in this regard.

A VIEW OF THE WORLD

Our view of the world, as of the spring and fall of 1995, was:

- DASD would continue to be the high-speed storage medium of choice over at least the next five years.
- The cost/GB and size would continue to decline while performance would improve. We were told we could expect to see DASD on a chip by the end of the century.
- The controller’s role had surpassed that of the DASD itself. In fact, we were told that we could be given the DASD free and pay for just the controller. (Actually, this would be closer to 60 percent for DASD and 40 percent for the controller.)
- RAID in some form (1,3,4,5,6,S, etc.) would be the only way DASD would be acceptable in a production environment.

MARKETING APPROACHES

With the caveat of saying I am not “seeing the forest for the trees”, I found the following marketing approaches used by our vendors.

- EMC: I found EMC’s marketing strategy to be very traditional—perhaps identical to IBM’s 10 to 15 years ago. It’s a traditional focus on meeting business needs—top down marketing through the marketing representative and other available resources. Bottom up marketing through system engineers and technical staff. I found EMC to be aggressive, sensitive to our requirements, and willing to go beyond the existing paradigm of selling its product. For example, instead of bidding the requested DASD requirement, it made a bid which included buying the existing lease on our remaining DASD. This appeared to be attractive in that it could solve several other problems at the same time. My interest in sequential prefetch led EMC to bring me to its production facility to talk with its engineers. EMC’s strength is high performance DASD, and its direct and indirect marketing is done to preserve this image. To EMC, performance solves business needs, which translates to cost savings (sounds like IBM a while back).

- IBM: IBM’s product base is huge. Both top-down and bottom-up marketing has evolved away from traditional approaches. As a small customer, we have suffered from this fallout. Our day-to-day support has evolved to an 800 number with someone back East. IBM intended to have this person be a point-of-contact from whom information could be obtained or who could provide the proper resource. This technique has some value. Unfortunately, it did not work too well when I had to explain to our contact that MVS was a large operating system. Our contact was unaware of our need for DASD until we notified him. As a result, IBM was behind the others in gathering and presenting information. On the positive side, IBM is providing industry-focused marketing representatives. In addition, I have always enjoyed open access to IBM’s technical staff who have provided many valuable insights into their area of expertise.

- STK: STK’s marketing is very much like EMC’s—an aggressive marketing representative with very competent system engineers. We have STK tape drives, and STK has actively marketed its newer drives and ATLs to us. Meanwhile, it has maintained personal relationships. STK’s “ICEBBERG” is state-of-the-art DASD, providing the highest functionality. It seems to be accepted in today’s marketplace.

- HDS: HDS’s marketing approach appears similar to those of EMC and STK. However, we see that it is suffering the same resource constraints as IBM. There is a gradual shift away from traditional marketing practices to techniques that leverage HDS resources. It uses its preferred vendor status to maximum effectiveness. It also uses its regional DASD specialist to identify and articulate the advantages of the HDS DASD.

DATA COLLECTION

Each vendor was briefed on our current configuration, historical capacity, and performance. We gave them open access to our system for data gathering purposes. Everyone used RMF data as input to their modeling tools to provide performance estimates for their DASD. They all had the capability to use GTF traces as input to more extensive modeling tools.

HDS has its own set of tools and performed a preliminary study. However, it failed to interview us about our specific needs. As a result, it presented an analysis and recommendations that were not in line with our requirements. I told HDS that the HDS 7700 was not a candidate because it was too new and had not gone to GA. After it became generally available, HDS made a special presentation on the HDS 7700. Based on this and our vendor relationship, we included it in our decision-making process. A regional specialist with HDS, who was very familiar with our system when he was the consulting systems engineer, performed a more extensive analysis.

STK used its own set of tools, part of which focused on the benefits of compression—a unique feature of STK DASD.

EMC used a simulation feature of Legent’s (Computer Associates’) ASTEX to measure cache effectiveness as it related to its DASD.

IBM, like the others, used RMF data as input to its model for estimates. A year earlier, IBM’s Bruce McNutt had run a 24-hour GTF trace, and presented an analysis and recommendations relating to our sequential prefetch problem. His theory on the relationship and benefits of controller cache and host buffers helped us understand our problems.

All of the vendors provided results showing improvement over our existing platform. While impressive, there were so many variables to be taken into account that we could not attach a significant weight to the results. We preferred to have the stated improvements included in our purchase performance guarantee.¹

Data collection also included numerous discussions on the various device architectures and how they applied to our environment. We had many misconceptions that often needed to be corrected.

FRONT, MIDDLE, AND REAR

All of the vendors attached ESCON to the front end of their controller. IBM claimed it was the only one to take full advantage of the 17 MB channels. EMC and HDS claimed an effective rate of 12.5 MB. STK was limited by its compression chip to bus-and-tag speeds, but its newer chips now run at

¹Vendors’ performance guarantees are usually negotiated on mutually agreeable terms, such as RMF response time measurements for peak periods. If the agreed upon criteria have not been met, it is under-stated that the resolution will be in the form of hardware upgrades, such as additional cache or an additional controller, if necessary.
ESCON speeds (10 to 12 MB). With STK’s compression on the front end, effective storage can be increased, and because the data streams are shorter, a small performance improvement can be achieved.

On the front end, with a maximum controller configuration, EMC and HDS claimed eight paths to the host, while IBM and STK could muster only four. However, by splitting its RAMAC box, IBM could configure eight paths (an unusual configuration), or configure two 3990-6/RAMAC boxes as an eight-way. STK’s definition of a fully-loaded controller would be less than what EMC and HDS could claim.

**ROT:** Up to a certain limit, more and faster channels mean better performance.

All proposed DASD handled the I/Os out of cache. This eliminated the bottleneck of data being sent to the host from the backend and having a slower path speed. Everyone claimed, using their modeling tools, improved performance could be achieved by using large cache sizes. The days of 32 MB cache sizes are gone; 1- to 2-GB cache sizes and higher are more typical.

**ROT:** The more cache the better the performance (the law of diminishing returns applies).

STK uses log-structured files (LSF) for its caching/controlling algorithms. This provides advanced functions, such as virtual volumes. The downside is that the LSF system requires protocol overhead. Competitors claim that LSFs promote fractured logical volumes, which are user unfriendly to sequential processing.

All of the vendors kept two copies of the data using NVS (non-volatile storage). These are kept in two different locations, thus enabling the vendor to claim a “fault tolerant” device. EMC does not keep two copies of the data in separate locations but rather on a single board. One cannot claim “fault tolerant,” but dual copies are kept (on the board). This is a subtle difference, but having the data on the same board results in a significant performance benefit.

**AND IN THE REAR…**

The rear configuration is the most hotly contested area among the vendors: These configurations vary with most using “Fast/Wide” SCSI-2 type drives spinning at 5400, 6300 (HDS), or 7200 RPM (IBM). The disks are either 2.1, 4.5, or 9 GB. The higher density devices are subject to performance constraints simply because their areal density becomes more noticeable as the I/Os become less cache-friendly. For example, in a non-cache-friendly situation, two active data sets on two actuators will perform better than two active data sets on a single actuator.

The rear channel speeds are SCSI-2 10-12 MB (STK drives this only at 5 MB, but is passing compressed data, claiming effective 12+ MB transfer rates). IBM uses SCSI drives with 12 MB speeds, staging the data into 64 MB of “drawer” cache. This is limited by the 4.5 MB transfer speed from the cache (drawer) to the controller.

EMC and HDS have two or four actuators on a SCSI path. EMC uses a 1 MB actuator level buffer along with preemptive SCSI command processing (SCSI “tag commands”) to mitigate the path contention. Four SCSI paths tie into a disk director. Two disk directors are cross-configured. This allows one director to take over the function of the other in the case it may fail.

HDS’s disk directors (referred to as Array Control Processors [ACPs]) are like EMC’s, except two are packaged together using “dual-ported” disk directors. This provides an alternate path to the other director’s actuators—not just for failure purposes, as in EMC’s case.

STK has a different approach. It has 14 separate paths (plus two for control) on the backend (four from each of four disk directors — called Device Interfaces). Eight paths are read/only and eight are write/only. Each path can access any actuator, also claiming better availability.

**ROT:** The more actuators the better the performance; the faster spinning the device the better the performance; the less data per actuator the better the performance.

As mentioned earlier, all of the vendors use RAID DASD of one form or another. EMC offers a choice of several RAID DASD configurations. STK is the only vendor offering double fault tolerant RAID DASD (6+).

**ROT:** RAID greater than zero is fault tolerant. So for RAID greater than zero, RAID is RAID no matter what the number. The higher the RAID number the more efficient is the use of DASD. For RAID greater than 1, the poorer the performance (write penalty).

Listening to claims on rear-end architectures is interesting. All vendors use SCSI drives with actuator level buffers. Their path speeds are approximately the same. Therefore, on a single I/O from the rear, one could expect a maximum transfer to be the bandwidth of the SCSI device (assuming fully buffered data at the actuator). However, faster aggregate transfer rates can be claimed using the characteristics of RAID designs. Typical RAID configurations have N actuators with N-1 actuators for data and one actuator for parity. In a normal configuration, a data set is striped across the N-1 actuators. So one has de facto striping. Therefore, HDS, which uses seven disks for its RAID DASD, claims an 87.5 MB bandwidth on sequential reads.

STK could make a similar claim (except it has N= 13). IBM’s RAID 5 has a N= 4 configuration. EMC (RAID-S) has four actuators—three for data and one for parity. However, EMC does not stripe. It puts volume 1 on actuator 1, volume 2 on actuator 2, volume 3 on actuator 3, and uses volume 4 as a parity volume. Therefore, EMC only reads from a single volume. With six (or n) I/Os, EMC is reading from six (or n) volumes. In spite of these differences, all offer high performance.

EMC’s RAID-1 mirrored configuration means two copies on two actuators. The electronic dual write is very quick. The read can be even quicker and provides higher performance since one can read from either mirrored copy, whichever has the shortest access time (rotational delay/seek). This also provides de facto dual porting.

STK compresses the data on the front end. Using “logical” volumes, it creates its own version of its physical volume on the rear end. This makes it very difficult to evaluate performance advantages. Writes to the rear are packaged in striped cylinders of compressed data. Since this package of data would not necessarily correlate with real sequential data, it would seem that more data would have to be read in a situation where high sequential reads would occur.

**ROT:** The more/faster paths from the controller to the actuators the better the performance. The more actuators each path can access the better the availability and performance (the law of diminishing returns applies).

**PRESENTATIONS**

Each vendor made presentations between one and three hours long. One cannot briefly describe the content of their presentations, but all presented their DASD, highlighting features unique to their devices. All showed significant improvement could be achieved over our existing system.

IBM emphasized RAS and the steps it had taken to improve overall performance. It did not try to show differences with competing vendors.

STK did not focus on speeds and feeds, but did emphasize architecture (LSF), which allows virtual volumes and other functions.
HDS presented the HDS 7700 RAID system, which had just GA’d. It focused on its new architecture, noting the differences between itself and competing architectures. HDS presented some early information which showed the 7700 sustaining high I/O rates under test conditions.

EMC had the longest presentation, the first half of which was a high-level overview of EMC. The technical part of the presentation reviewed the Symmetrix 5500 architecture and study results.

**APPRAISALS AND REBUTTALS**

Each vendor was apprised of our first impressions, other vendors’ comments, and open issues considered important. We used customer referrals and personal contacts.

We took this opportunity to review our status with the Gartner Group and Meta Group. This did not reveal any radically new information except to confirm our existing opinions. They did relieve our concern about the newness of the HDS 7700, saying that if the price were competitive, we should consider the product.

Vendors marketed against the label of “old” architectures by stressing the potential future improvements their controllers will have.

The vendors’ competitive conduct was good, with some minor exceptions. They tried to present the unique features of their DASD without misstating information about their competitors’ DASD. However, vendors often had information about a competitor’s product which was out of date. For example, STK was given negative marks for front-end performance due to its front-end compression. In fact, its newer compression chip (which should have solved that problem) was what was being marketed to us.

One vendor stated, “We have never lost data.” When the other vendor was apprised of this, it said, “That’s not true and we can prove it. All vendors have lost data.” When the first vendor was told this, it issued a retraction. It claimed that the person who had made the original statement may have said it in a limited context.

In another instance, a vendor called on us and brought one of its executives. During our discussion, this executive said, “I shouldn’t tell you this because it’s not for public knowledge...” and proceeded to tell one of us a future plan for a product. I have seen this happen on a number of occasions. I think this is a poor marketing practice used to sell products.

**ROT: If a vendor offers confidential information in a marketing situation consider it public knowledge.**

This might be a strong statement, but the normal procedure for this kind of practice is to have the customer sign a non-disclosure agreement.

The rebuttals were not formal presentations. They were conducted through a series of mini-meetings and discussions.

**RAS, PERFORMANCE, FUNCTION AND COST**

At this point, we reached some conclusions about each of our vendors in the following areas.

- **RAS:** We considered all of our vendors to have good RAS. IBM had perhaps the best RAS, based on its history in this area and its DASD architecture. STK’s RAID 6+ double fault tolerant design was very attractive. EMC could not claim the words “fault tolerant” because dual data was being kept on the same board. We had to weigh the significance of this knowing there are no truly fault tolerant systems (microcode, etc.).

- **Performance:** EMC was the winner in this area. Our information on performance was based on H. Pat Artis’s studies, information from our consultants, other studies, and several customers. However Artis’s work (to which we had access) was a year old and RAMAC II was now available. STK’s DASD had been measured with non-ESCON channels (EMC’s was on ESCON). STK’s DASD now has ESCON channels and a matching compression chip on the front end. HDS’s DASD was so new, we had only the vendor’s word on its performance (it claimed it could match or beat EMC) and on hearsay. EMC emphasized the affinity of its architecture to the sequential prefetch.

- **Function:** STK, with its LSF system, delivered the most function. The virtual volume concept is very attractive. The true benefits, which were within the reach of their architecture, seemed to be in the future. All of the vendors provided the equivalent of IBM’s extended function platform. EMC offered several unique functions, such as allowing DASD to be used for open systems use.

- **Cost:** EMC and HDS had the most expensive DASD. The others were competitively priced below EMC and HDS. Our consultants were very helpful concerning information on current DASD prices.

This concluded the initial phase of our acquisition process. We decided that if all things were the same (except cost), EMC would be the winner, primarily based on performance. However, we concluded that all...
of our vendors would provide improved performance, all would be “acceptable” if purchased, and cost would be a significant factor. What was the actual decision? EMC? STK or IBM for their price/performance? Or, was it HDS, with its new architecture? In fact, this article was written before the actual decision was made. Our business needs, simply stated, said we must postpone our decision. This dictated the outcome — extend our current leases and wait.

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