



IBM z/OS Version 2 — Ready to Go

Analyst: Stephen D. Bartlett

Management Summary

Sophisticated smartphone or tablet users will tell you that having very-well-endowed hardware is required for a great experience. They also would acknowledge that a best experience comes with the latest release of the operating environment, because this is the heart and soul of the offering. The same is true for IBM's mainframe, *System z*. The fact is that IBM mainframes from the first *System/360* announced in 1964 – its Golden Anniversary beckoning – to the present *zEnterprise* are defined by its instruction set, which of course is the building block for its operating system. There are other operating systems that support the Systems z architecture – including *z/VSE*, *z/VM*, and *z/TPF* – but *z/OS* represents the ultimate embodiment of IBM's mainframe architecture as first envisioned when *System/360* was announced.

The *zEC12*¹ announcement on August 28, 2012, included a number of new milestones in terms of its new technologies, performance, scale, availability, security, price-performance improvement, and extensions to its *zEnterprise* architecture. However, historically speaking, one could say that for any of IBM's prior mainframe family announcements. What was missing at that time was a new release of *z/OS* that fully supported the new functionality embodied in the *zEC12*. We had been forewarned at the SHARE users group in March 2012, followed by a Statement of Direction published April 11, 2012, that a new release was coming in the second half of 2013. The most newsworthy elements of this *z/OS* SOD announcement were:

- IBM was extending the period of support from three years to five years and changing its annual release update cycle from one year to two years;
- As a result there would be no Release 14, which would have been expected in September 2012; and
- Instead, mainframe clients should expect availability of a new version and release, Version 2 Release 1, (V2.1) to be available in the second half of 2013. (I estimated at that time that it would be in late September, based on IBM's track record.)

At the SHARE San Francisco meeting on February 4, 2013, IBM made a *z/OS* “preview announcement” followed by its publication on February 5, 2013.² Preview announcements essentially are what is implied by their name; it's a look at the important elements of a forthcoming announcement in order for *z/OS* decision-makers to anticipate what is to be formally announced soon, generally within six months, and to begin to formulate their plans accordingly; a teaser if you will. Although preview announcements usually are loaded with technical content (this one is 32 pages long), some technical and administrative details usually are omitted. Therefore, there always is cause for some speculation.

IN THIS ISSUE

➤ What's New in Version Two?.....	2
➤ Conclusion.....	7

¹ For more detail on the *zEC12*, see [The Clipper Group Navigator](http://www.clipper.com/research/TCG2012019.pdf) entitled *The IBM zEnterprise EC12 - Bigger, Better, Faster*, dated August 28, 2012, and available at <http://www.clipper.com/research/TCG2012019.pdf>.

² See <http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?subtype=ca&infotype=an&supplier=897&letternum=ENUS213-013>.

The waiting is over. In this **Navigator**, the details of the new version are described and discussed, including what's new, from a technical perspective, in the new version and release plus other factors that should be considered when deciding if and when the new version should be included in your IT plans. Please read on for more details and conclusions about *z/OS Version 2*.

What's New in Version Two?

Although support for all of the previously announced innovative features and functionality of the zEC12 – and now the zBC12³ – such as IBM *zAware*, exploitation of *Flash Express*, 2GB fixed pages, 100-way SMP single image⁴, and limited support for the *Transactional Execution Facility* already have been released for Version 1 Release 13⁵. The formal announcement now has been made and, as we expected, there are some new goodies, and a surprise or two, which were not previewed. **With z/OS Version 2.1, the System z folks move forward along a predictable framework that reinforces the corporate theme of innovations that support Smarter Computing along the axes of cloud efficiency at scale, data serving for operational analytics, and security to protect assets, while in no way compromising the “traditional” roles of the mainframe, and in many cases, enhancing it.**

Thirteen Years Between z/OS Versions – So Why Now?

Actually, it will be about three months shy of thirteen years between z/OS Version 1.1, announced in October 2001, and z/OS Version 2.1, announced today. *Why a new version?* Considerations for re-versioning are not taken lightly by the IBM's System z software folks and several factors usually come into play, frequently in combination, including:

- Rebranding
- Very significant technology innovation and content
- Changes in support and terms and conditions
- An architectural level set
- Pricing terms and conditions

The announcement of z/OS Version 2.1 should be considered a milestone, and in light of the incorporation of some five-hundred line items, and thus is a new base for all future development. About the only action *not* taken was a rebranding.

Support is Extended to Five Years and Release Cycle to Two Years

The increase from three years of technical support for each release to five years was announced at SHARE in Atlanta in March 2012, followed by a Statement of Direction published in April. This announcement was covered in some detail in a paper published by The Clipper Group at that time.⁶ Let's review the highlights. Effective with the general availability of z/OS V2.1, technical support (problem diagnoses, fixes, bypasses, or restriction on use) is extended to a period of five years, compared to three years currently. Therefore, the support period for V2.1 will extend to 2H2018. This will be accompanied by a change in the periodicity of the release cycle from one year to two. As a result, we should expect IBM to announce a new z/OS release, V2.2, sometime early in 2H2015.

We expect these changes to be a win-win for IBM's customers and IBM itself. **Data center technical and management staffs, who currently are occupied with release-to-release planning and migrations, now will have more time to focus on the longer term and, thus, will have more time to exploit any new z/OS functionality.** The overall System z headcount could be reduced or, preferably, redeployed to development projects or the expansion of services to the client community. It is hoped – reasonably – that with fewer and longer migration cycles, customers will be more likely to maintain their currency, which – for some – now are several releases behind. **Improved currency will facilitate the adoption of the latest technology, both hardware and software, as**

³ For more detail on the new zBC12, see **The Clipper Group Navigator** entitled *The IBM zEnterprise BC12 – When Smaller Does the Job Better and Faster*, dated July 23, 2013, and available at <http://www.clipper.com/research/TCG2013013.pdf>.

⁴ For more detail on these architectural extensions in the zEC12, see **The Clipper Group Navigator** entitled *The IBM zEnterprise EC12 - Bigger, Better, Faster*, dated August 28, 2012, and available at <http://www.clipper.com/research/TCG2012019.pdf>.

⁵ With some exceptions, all new features of the zEC12 that shipped in August 2012 were supported by z/OS V1.13 via PTF software updates.

⁶ See *The Clipper Group Captain's Log* dated April 11, 2012, entitled *IBM Changes Its z/OS Release Plan and Extends Its Support*, and available at <http://www.clipper.com/research/TCG2012007.pdf>.

well as encourage fuller exploitation of the latest z/OS features and functions that will deliver improved services and better efficiency.

In addition, if integration of ISV products is required, which is a very likely situation, there will be more time and flexibility for all parties to address any compatibility issues that may arise. Once implemented, the effect of these changes should go directly to the data center's bottom line and reduce the TCO for z/OS support and operations. IBM, in turn, will have more time to develop and test each new release, resulting in a cleaner delivery and improved customer satisfaction. With its customers at a higher state of currency, IBM should be less likely to have to revisit problems or incompatibilities that have already been addressed in later releases. If viewed as a customer satisfaction issue and if this new practice is as popular as IBM expects it will be, the business case for continued adoption of mainframe technologies will be enhanced. Between releases, IBM will add support for new hardware, whether system or I/O, and implicitly, new features and functions as required, as well as to issue corrective PTFs. While few software vendors openly like to focus attention on "how we fix our bugs", IBM's ability to reliably handle, fix, and distribute modifications to System z software truly is world class.

Architectural Level Support is Reset

Architectural Level Set (ALS) is "IBMese" for identifying the earliest level of the System z architecture that is to be supported by a particular version or release of z/OS. This is most important to those enterprises that are not at the latest level of mainframe hardware and operating system technology. **With the announcement of z/OS V2.1, the ALS will be reset to the z9 EC and z9 BC (a.k.a. G9⁷) and later, therefore the z900/z800 and z990/z890 will not be supported by the new z/OS version.**⁸ The last ALS was set in 2004 with z/OS V1.6. This bit of history is significant because it demonstrates IBM's commitment to protecting the investments of its mainframe customers, not forcing operating system upgrades with each new generation of

hardware and vice-versa. These facts notwithstanding, it is generally understood that the latest System z architectural features, performance, reliability, and security are available with the combination of the latest hardware generation and new z/OS release, to wit, zEC12, the zBC12, and z/OS V2.1.

It's All about Enterprise Data

System z including its supporting storage subsystems always have been a "Big Data" system. A reasonable claim could be made that most, if not nearly all, of the largest commercial data repositories are hosted by IBM mainframes. Progress in that area continues to be a focus for z/OS V2.1. Data is "smarter" when it is readily available and stored in the most optimum location that facilitates performance. Policy-based management of data is being implemented in the z/Enterprise's storage management subsystem, *DFSMS*. New in z/OSV2.1, policy-based management is extended further to data in active storage tiers. With *DFSMS*, selectively all data stored on channel-attached storage devices, such as the *DS8000* array's SSD (solid-state storage), HDD (hard-disk devices), or SATA (serial advanced technology attachment) devices, are assigned a class based on age and elapsed time since last reference. The result is lower latency in that the most active data is closest to the computing resources.

System performance and availability are also being addressed by *VSAM RLS (Virtual Storage Access Method Record-Level Sharing)*. This is particularly important to reducing contention, (i.e. eliminating compute processors (cores) having to wait for data) where data, such as those contained in catalogs, is being shared by many entities. It also eliminates the need to provide multiple catalogs as a method for improving performance, thereby improving manageability.

A new type of data compression, *zEnterprise Data Compression (zEDC)*, is being introduced exclusively in z/OS V2.1 for the zEC12 and the zBC12 processors. *zEDC* is a very efficient compression algorithm (up to four times faster for SMF logstream compression) and is designed to deliver high-performance, low-latency compression. As a result of the compression workload being offloaded to a new PCIe I/O feature, the *zEDC Express for zEC12 and zBC12*, there is very-low CPU overhead. Use of this new PCIe I/O based compression facility will reduce latency and thus drive better efficiency for

⁷ The z9 family is known internally as the *Generation 9 (G9)*, working its way up to the zEC12 and zBC12, which is *G12*, the most current generation. The origin of the generations as referred to here is marked from the first System/390 CMOS processor family announced in 1994.

⁸ The z/OS V1.13 ALS extends back to G7, announced in 2000, and G8, announced in 2003.

cross-platform data transfers, storage devices, and networking bandwidth. It potentially could be used for file types that are not optimized for on-chip compression. The first use case will be compressing before writing SMF log data, which can be quite voluminous. z/OS V2.1 also will provide support for the *zlib*, the open source library for compression and decompression, which is compatible with zEDC Express. Statements of Direction⁹ for this feature include future provision for BSAM/QSAM extended format sequential data sets, JAVA data streams, as well as data managed by DFSMS; no dates were specified.

Batch processing is not forgotten; it remains an essential element of all enterprise computing portfolios. Forget the after-hours batch window – it's closed. Unlike distributed platforms, batch workloads fit nicely into the background of *System z Central Processing Complex (CPC)*, as the mission-critical workloads continue to maintain their service levels. IBM's z/OS developers continue to maintain focus on improving performance in that arena. One example is retrieval of migrated data sets that are required for a batch process; this activity can be a significant pinch-point to initiation of the workload. New function has been added that facilitates the *parallel* recall of the required datasets as opposed to *serial* processing.

Optimized for Efficiency at Scale – Ready for the Cloud

In the IT blogosphere, the mention of *mainframe* and the anything *cloud* are infrequently paired in the same sentence, except to deny its applicability. I have argued against that premise and substantiated it.¹⁰ IBM continues to vigorously meet the evolving needs of cloud computing by expanding the capabilities of the zEnterprise system and the operating environments supporting it.

When speaking of scale, support for zEC12 100-way SMP (Symmetric Multiprocessing) bears mentioning, although not unique to z/OS V2.1¹¹. This translates to a single z/OS image of

approximately 78,000 MIPS on a fully-configured zEC12,¹² whereas the new zBC12 will support about 4900 MIPS in a single footprint – about ten times the footprint of the z800 of ten years ago. Very few, if any, Business Class clients will need to expand into the lower end of the zEC12 but it should be reassuring to those having capacity constraints that IBM's engineers have provided a solution, scaling up as well as scaling out.

Improvements in memory management as well as performance are provided by 2GB fixed page support and 1MB page frames. Additional relief from paging delays is provided by the Flash Express feature in which SSD (solid-state disk) memory via a PCIe I/O card is used for paging data. Early exploiters will be JAVA, IMS, DB2, and *any* other workloads which benefit from JAVA's use of larger pages, as well as workloads taking diagnostics (dumps).

The *Transactional Execution Facility*, also called *transactional memory*, had limited support in z/OS V1.13, but full exploitation is realized in Version 2.1. Transactional memory provides the ability to execute a group of instructions atomically, that is, either all their results are committed or none is, as a true transactional process. There is no need to lock memory locations, as parallel execution is enabled, resulting in greater efficiency of exploiting software. In addition to the JAVA support already enabled in z/OS V1.13, the new version extends it to *IBM XL C/C++* and *High Level Assembler*. Other compiler and middleware support is likely to follow.

Introduced in z/OS V1.12, *z/OS FICON Discovery and Auto Configuration (zDAC)* addresses issues related to the management and configurability of complex I/O environments. Now with z/OS V2.1, in addition to switch-attached controllers, zDAC now supports the discovery and configuration of non-switched attached (point-to-point) devices. This improves the usefulness of the feature in smaller installations, such as those typically supported by the zBC12 and its predecessors, and provides a boost in its performance as well.

Not previewed in February – and exclusive to z/OS V2.1 and the zEC12 and the zBC12 – is a new communications feature, *SMC-R (Shared Memory Communications - RDMA)*. SMC-R is

⁹ IBM Statements of Direction are subject to change or withdrawal without notice, and represent goals and objectives only.

¹⁰ See [The Clipper Group Navigator](http://www.clipper.com/research/TCG2011034.pdf) entitled *IBM's zEnterprise Really Stretches Its Boundaries - New Windows Are Opened*, dated October 12, 2011, and available at <http://www.clipper.com/research/TCG2011034.pdf>.

¹¹ Support for 100-way SMP is also available for z/OS V1.12 and V1.13 via APAR.

¹² Obviously this does not apply to the zBC12, or any prior System z for that matter, because of their inherent design limits.

similar to *HiperSockets* in that it provides fast memory-to-memory transfers between z/OS processors or LPARS; it lowers CPU overhead (no CPU cycles are consumed), reduces TCP/IP overhead and network latency, and drives more efficient system utilization. It also has the added benefit of being application transparent, which means it can be exploited immediately to achieve these gains. The SMC-R communications fabric, *RoCE* (pronounced “rocky”), uses an open source protocol, *RDMA (Remote Direct Memory Access over Converged Ethernet)*, which is being adopted broadly within the IT community. In addition to its application transparency, it leverages existing Ethernet infrastructure and preserves the security and operational model of z/OS TCP/IP sockets. The feature is available immediately for the *IBM WebSphere Application Server (WAS)*, *IBM CICS TS*, and others. Exploiting SMC-R networking will require at least two *10GbE RoCE Express* features, newly announced for the zEC12 and zBC12.

Another new capability, known unofficially as *CF (Coupling Facility)*¹³ “notepads” is being introduced in z/OS. This new facility provides a simple, easy-to-use API to store and access data, such as transient data in a CF structure. One major software vendor, *SAP*, is exploiting this new API to enhance their deployments of high-availability ERP systems. Using this structure, *SAP* is replicating and using the ENQ server information within the CF, resulting in improved application performance and throughput. The exact performance improvement resulting from this implementation is not available at this time; however, its significance in terms of the integration of an exclusive z/OS feature within an independent software vendor’s “deep” code is, to some degree, a strong endorsement of IBM’s System z platform and the integrity of its ecosystem. Expect more exploitation of this facility in the near future.

Security Extensions – Cryptography Now Beyond z/OS

Many knowledgeable IT folks (and users as well) recognize System z as the benchmark for secure system architectures, but until recently essentially has been limited to resources that are managed through z/OS, be they servers, I/O devices, or network connections. There should

be little argument that protecting cryptographic keys should be a key objective of any enterprises’ security strategy; centralization of those controls offers the best opportunity to achieve that goal. In concert with the extensive security structures already embodied in the System z architecture, z/OS V2.1 is being extended to offer “*Cryptography-as-a-service*”. This allows applications running on any Linux-supported server – be they located on IFLs running *Linux for System z (zLinux)* or Linux supported *IBM System x* blades located in an *IBM BladeCenter Extension (zBX)* within a zEnterprise ensemble – to avail themselves of System z cryptographic services.

In addition, *IBM Tivoli Directory Server* will provide support for the Lightweight Directory Access Protocol (LDAP)¹⁴ to enable remote applications to encrypt data transmitted over networks, storing objects via the *Integrated Crypto Services Facility (ICSF)*, a feature of z/OS. System z and z/OS further extend their support of the open source community by providing cryptographic services via *OpenCryptoki (Cryptographic Token Interface)* available for inclusion in Linux distributions. Continuing to lead the industry in the implementation of security and cryptographic standards is further demonstrated by z/OS adding support for higher-strength crypto ciphers and conformance with United States government cryptographic algorithm policy for national security applications (*NSA Suite B*). It’s appropriate to be reminded here that System z’s unique virtualization architecture embodied in its *PR/SM (Processor Resource/System Management)* facility and *RACF (Resource Access Control Facility)*, hardware/firmware and software, respectively, are designed to be certified at the Common Criteria EAL 5+ level, the highest level achieved to date by any commercial grade products.

Leaving the Green Screens Behind

System z has had a bad rap for being difficult to manage all of its bells and whistles and the magnitude of its potential resources. Improving automated operations and making management functions more intuitive continues to be addressed by *z/OSMF V2.1*, a no-charge component product used with z/OS V2.1. An issue of concern to most enterprises is the

¹³ A CF is used to share and synchronize data in two or more Central Processor Complexes in a Parallel Sysplex configuration.

¹⁴ LDAP is an open, vendor-neutral architecture that has become the *de-facto* standard for directory information vital to the management of modern distributed heterogeneous systems.

improvement of the visibility of its software resources, which could be in the hundreds of titles and numerous vendors. z/OSMF functions are being enhanced to manage the system complex's *SMP/E-managed*¹⁵ software portfolio through a GUI interface that will report on service levels and currency, improve controls of maintenance and assist in lifecycle support and planning. In addition, a new *workflow* infrastructure has been introduced to simplify the sequence and management of configuration tasks that often engage the several different roles played by those with varying levels of technical skill. This new facility directly addresses the issue of allocation of limited people resources in a way that can optimize their deployment and thus reduce operational costs. And to enhance startup and optimize its footprint, z/OSMF 2.1 uses the more efficient *Liberty*¹⁶ profile in *WebSphere for z/OS*, which contributes to a more resource-efficient footprint and processor usage.

To support performance management, capacity planning, and workload optimization and management, the *Resource Management Facility (RMF)* has been enhanced to report performance metrics across the entire zEnterprise hybrid ensemble. In addition to the cross-platform metrics for Linux on System z, Linux on running *zBX System x* blades, and *AIX* running on *zBX Power Systems* blades, RMF has added support for *Microsoft Windows 2008 Server* on *zBX System x* blades. Also significant, but more likely to escape notice in the flurry of this announcement, are implementation enhancements to RMF, whereby a portion of its processing requirements is off-loadable to a *zIIP*¹⁷ processor, thus lowering z/OS overhead.

Also, a new capability has been added to z/OSMF – *z/OS Jobs REST API*¹⁸ – which allows users on other platforms to securely bridge batch workloads with web applications

without a z/OS log on. Browser-based applications running through a secure HTTPS connection will be able to submit scripts that will initiate z/OS batch jobs and then will be able to monitor their progress all the way through notification of successful completion. Secure access to all of a z/OS mainframe capabilities can now be achieved easily by broad communities with their unique sets of needs, putting aside those critics that may continue to claim that mainframes do not play well in modern infrastructures.

Pricing the New Version

There is no mention of pricing in the preview announcement, but the formal announcement included some pricing changes in z/OS that will be introduced in Version 2.1. Before I elaborate on this always sensitive topic, let me briefly review the recent pricing history of z/OS. Since the first release of z/OS Version 1 in 2001, there have been two pricing changes that have affected z/OS. The first, which was effective April 2009, was a general price action that included a broad range of System z software products (e.g., *CICS*, *DB2*, and *IMS*) resulted in increases ranging from 0% to 3%; with lower-capacity systems seeing little or no increases. More recently, effective in April 2012, specifically for all releases of z/OS Version 1, prices were increased and average of about 5%, dependent on the system capacity being licensed. Notably, “business class” systems were exempted, those to which *EWLC* and *AEWLC*¹⁹ pricing metrics applied, e.g., *z114*, *z10 BC*, and *z9 BC*.

Given the extensive degree of technical enhancement affecting many of the subsystems that improve system performance, availability, security, and reach of the System z architecture, and the extended service period, a price increase was deemed appropriate at this time. z/OS V2.1 users should expect approximately a 5% increase in monthly charges for the same capacity and usage. There will be no new pricing metrics; *AWLC (Advance Workload License Charge)* still applies to the *zEC12*, and *AEWLC (Advance Entry Workload License Charge)* will apply to the newly announced *zBC12*. Neither will there be any new tiers added or tier adjustments to those metrics.

However there will be one new wrinkle

¹⁵ SMP/E (System Modification Program/Extended) is a tool designed to manage the installation of software products of a z/OS system efficiently and to track the modifications to those products.

¹⁶ Liberty is a JAVA-based application server profile that facilitates simple and quick development and provides a dynamic, small footprint runtime that minimizes the use of system resources.

¹⁷ zIIP = System z Integrated Information Processor, a non-z/OS processor designated for special purpose workloads.

¹⁸ The REST API is a set of operations that can be invoked by using the actual URL as parameters for various operations.

¹⁹ EWLC = Entry Workload License Charge; AEWLC = Advanced Entry Workload License Charge.

introduced with the pricing of the zEDC feature, which is unique to the zEC12 and zBC12 supported by z/OS V2.1. There will be *both* a hardware charge, which will be fixed based upon the quantity of featured I/O cards installed, and a charge for the enabling software, which will be variable based essentially on usage. There is some advantage gained here by smaller scale systems that implement zEDC, which by their nature, have lower software charges. It is very likely that IBM will extend this practice to similar features in the future.

Conclusion

I expect that IBM z marketing folks will be emphasizing that the readiness of the new version in concert with the zEC12 and zBC12 represents the most complete embodiment of System z to date and one that will address the ever-growing needs of its mainframe customers for cloud computing, data analysis, emerging technologies (such as mobile computing), and traditional mainframe workloads in the most secure environment. Under the rubric of a *Smarter Planet*, a number of integrated solutions (hardware, software, planning and implementation services) for a number of industrial sectors (including banking, government, health and life sciences, insurance, and retail) will be or are about to be available on these zEnterprise platforms.

However, none of this addresses the question as to whether z/OS V2.1 should be on front burner for earliest possible implementation. As always, your results may vary, but the new version is rich in *useful* content, and that is key to any future plans for installing this release. There are at least two compelling cases to upgrade to V2.1.

- **The first is when your latest release in production in the enterprise is V1.12, or older.** This release will go out-of-service as of September 30, 2014. With about 15 months lead time, now would not be too early to begin the planning and testing to be ready for cutover before that date. Earlier releases are already out-of-service, so they are either running unsupported by IBM services, or the installation has contracted for fee-based corrective services, in addition to the monthly licensing charges.
- **The second would be if there are technological features embodied in the zEC12 or zBC12 that are essential to achieving the**

business goals of your enterprise. These would best be achieved through implementation of z/OS V2.1.

If your enterprise falls into either of these scenarios, the new version of z/OS should be in your immediate plans.

With z/OS V2.1, the future has arrived. Now is the time to think hard about getting on board!



About The Clipper Group, Inc.

The Clipper Group, Inc., now in its twenty-first year, is an independent publishing and consulting firm specializing in acquisition decisions and strategic advice regarding complex, enterprise-class information technologies. Our team of industry professionals averages more than 25 years of real-world experience. A team of staff consultants augments our capabilities, with significant experience across a broad spectrum of applications and environments.

- **The Clipper Group can be reached at 781-235-0085 and found on the web at www.clipper.com.**

About the Author

Stephen D. (Steve) Bartlett is a Senior Contributing Analyst for The Clipper Group. Mr. Bartlett's interests include enterprise solutions including servers, system software, middle-ware, their underlying technologies, and their optimal deployment for responsiveness to emerging business requirements. In 2010, he joined the Clipper team after over 42 years with the IBM Corporation as an account and program manager in large system sales, product development, strategy, marketing, market research, and finance. During that time, he received several awards for his contributions in innovative market research and contributions to the business. He has a B.S. from Rensselaer Polytechnic Institute, and an M.S. from Union College.

- **Reach Steve Bartlett via e-mail at steve.bartlett@clipper.com or at 845-452-4111.**

Regarding Trademarks and Service Marks

The Clipper Group Navigator, The Clipper Group Explorer, The Clipper Group Observer, The Clipper Group Captain's Log, The Clipper Group Voyager, Clipper Notes, The Clipper Group Calculator, and "*clipper.com*" are trademarks of The Clipper Group, Inc., and the clipper ship drawings, "*Navigating Information Technology Horizons*", and "*teraproductivity*" are service marks of The Clipper Group, Inc. The Clipper Group, Inc., reserves all rights regarding its trademarks and service marks. All other trademarks, etc., belong to their respective owners.

Disclosures

Officers and/or employees of The Clipper Group may own as individuals, directly or indirectly, shares in one or more companies discussed in this bulletin. Company policy prohibits any officer or employee from holding more than one percent of the outstanding shares of any company covered by The Clipper Group. The Clipper Group, Inc., has no such equity holdings.

After publication of a bulletin on *clipper.com*, The Clipper Group offers all vendors and users the opportunity to license its publications for a fee, since linking to Clipper's web pages, posting of Clipper documents on other's websites, and printing of hard-copy reprints is not allowed without payment of related fee(s). Less than half of our publications are licensed in this way. In addition, analysts regularly receive briefings from many vendors. Occasionally, Clipper analysts' travel and/or lodging expenses and/or conference fees have been subsidized by a vendor, in order to participate in briefings. The Clipper Group does not charge any professional fees to participate in these information-gathering events. In addition, some vendors sometime provide binders, USB drives containing presentations, and other conference-related paraphernalia to Clipper's analysts.

Regarding the Information in this Issue

The Clipper Group believes the information included in this report to be accurate. Data has been received from a variety of sources, which we believe to be reliable, including manufacturers, distributors, or users of the products discussed herein. The Clipper Group, Inc., cannot be held responsible for any consequential damages resulting from the application of information or opinions contained in this report.