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All Nodes Are Not Created Equal — Thinking Differently About the Grid Nodes

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Management Summary

"Grid architectures make no sense for commercial applications." "Commercial symmetric multi-processing (SMP) servers have no place in a grid architecture." While many believe these propositions to be true, both are wrong. You do need to think differently, however, about using grids for the wider commercial needs of the enterprise.

A typical grid in academic and scientific computing environments strives to deploy physical assets against workload and data retrieval needs both opportunistically (using whatever capacity is available) and optimally (in terms of resource utilization). The grid provides assets with more flexibility and more comprehensive use. This is also exactly what commercial enterprises are seeking, but **grid deployments for commercial data processing require more capabilities than traditionally occur in academic and scientific grid environments.** These enterprises may need to use the grid pervasively (on a continuing, rather than on an as-available basis), to include some of their existing heterogeneous data center assets, and to set their own terms (for security, manageability, integration, and coordinated application functionality). **Using an architecture developed, largely, as a narrow-use paradigm to deploy a wide variety of concurrent and interrelated commercial applications presents many challenges.** For many of these workloads, parallelization may be impossible or does not help speed processing. Input/output may be more important to throughput than straight-out processing power.

It is tempting, and common, to think of a grid as a physical-level manifestation of PC-like nodes connected across networked distances. **It is better to think about the functionality, in terms of work to be processed and data to be delivered, that a grid provides to the enterprise.** If you take this approach, you become less concerned about the physical characteristics of the servers and more concerned about having enough power in the grid to accomplish the work or deliver the data in the required time frame, i.e., when it is needed. **This is an important shift in thinking – from a focus on sharing and utilization of physical assets to a focus on achieving multiple goals for work completion in a cost-effective manner.**

This reorientation clears the way to think about including in the grid larger SMP servers that are the mainstay of key applications for many enterprise data centers. Typically, these large servers can be partitioned to run multiple workloads at the same time. This may be disconcerting to those who think of grid assets as a collection of distinctly-separate, singularly-identifiable processing engines; but partitions are a well-established, virtual way to deliver variably-powered processing to an application**. So think about a grid node, at a higher level, as a vehicle for delivering a given amount of processing power. It makes no difference whether it is physically defined or virtually partitioned, except possibly in the total cost of ownership.**

The SMP server can bring to the grid a richness of capabilities. It can be defined on the fly as one or more virtual nodes of varying capabilities, allowing it to execute many different kinds of workloads, flexibly and opportunistically. Deploying an SMP server as a virtual set of nodes (or mega-node) in a grid can be more cost-effective than the many small physical nodes that otherwise might be required to get all of the work done, when it needs to be done. Read on to understand the many ways a mega-node can work in an enterprise grid. **Remember, it's all about achieving collective results in a most flexible way at an advantageous cost.** It is not about perpetuating last decade's preconceived notions.

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Expanding the Concept of the Node

Servers, switches, appliances, and storage arrays have so many overlapping functionalities that it becomes productive to think of them all as nodes with particular functional attributes. Virtualization techniques allow nodes to be aggregated (pooled) for simplified management via clustering (for servers), RAID (for storage), alternate pathing (for switches and ports), and workload scheduling (workload managers, multiplexing, and grid, etc.). **Any vehicle that allows allocation of resources to a node without the node necessarily possessing identical physical characteristics is *virtualization*.**

Many larger physical nodes have a divisible capacity in the form of ports, zones, LUNs, and, in the case of servers, partitions (via hardware or software, native or appended). The ability to disaggregate and re-aggregate at multiple levels turns a simple topography of physical assets into a much more flexible environment. To date, grids have not taken advantage of this flexibility.

Today's computational grids[1] use dedicated machines or idle-cycle harvesting schemes to support massive tasks that can be subdivided and run in parallel in academic or scientific computing environments. While faster throughput is the goal, "fast" for these massive, typically long-running workloads is not the same as the need to process a business transaction instantly. Non-computational data grids have been developed to distribute content, particularly large files. **Both computational and data grids typically involve dedicated homogeneous herds of similar small servers called "nodes"**. (See Glossary on the next page.) **In these nodes, the level of granularity for work is the entire server.**

The ability to partition a server to run more than a single application is not usually considered in a grid environment. Either the applications were large and subject to parallelization (think "scientific") and thus consumed all of the available processing power, or it was not relevant that some of the processing power wasn't being used. Either it was too hard to consider or the node was deemed to be "cheap".

Often, many of these nodes reside in the same rack or in adjacent racks. Think of a room filled with identical rack-mounted servers, with 10 or more per rack. Data centers are full of these today. These nodes can be distant as well. **They become a grid when they are networked together under some kind of grid management software.** The network and grid manager make them look like they are a pool of servers, although distance can be a factor in performance.

More Node Varieties

With blade servers, the computing industry has moving toward a more optimized and manageable configuration that places many nodes in a single box. **These multi-node blade servers still deliver each blade separately to the grid pool.** This is in contrast to SMP servers that can allocate more than one processor (and, usually, shared access to memory) to execute a large application. ***Multi-node servers* (whether blade or SMP) can also be seen as a *grid-in-a-box***, with dozens or hundreds of processors working under the control of a grid manager that resides inside.

While it may be harder to visualize, **consider a *mega-node* that consists of several of these multi-node servers within the same cabinet. Usually, this is a larger SMP server with *partitions* carved into smaller *domains*, each capable of executing isolated work on these virtual multi-nodes.** This is akin to having multiple grids in the same box, a *multi-grid*.

So there are many shapes that a grid or multi-grid may take, once we open our minds to new thinking. **It is not about the grid's physical implementation at the box or processor level but about the application's view of the server to which it is delivered for execution. It is not about the many manifestations of a physical grid; it is really about the multiple capabilities of a logical or virtual grid.**

Fitting the Grid to the Enterprise

The benefits of grid architecture come at different levels. **Grids' inherently distributed governance offers the opportunity to optimize as unused assets become available.**

- At a physical level, grids can optimize the use of resources.
- At a logical level (say, in a data grid), they can optimize access to information.
- At an application level, they can provide a highly available and flexible deployment infrastructure.

[1] See *Computational Grids - Server Consolidation for a Distributed, On-Demand World* in the May 16, 2007, issue of Clipper Notes available at http://www.clipper.com/research/TCG2007063.pdf.

- At a data center level, grid protocols can link data centers functionally, giving another layer of resilience.

The grid infrastructure template fits well with today's need to link processes together on multiple levels. Both are information-processing structures created to deal with complex environments. Managing the environment as a whole (to the benefit of many) as well as the sum of its parts is crucial to both grid and traditional data center operations**.**

The challenge of bringing grid architecture to the commercial enterprise is partially due to a mismatch between the original "distributed" approach of grid philosophy and the traditionally optimized (i.e., integrated) workload engines of the enterprise data center. **Incremental processing in the grid provides access to *more resources. This* is only as valuable as the *more* can be deftly managed and used in the context of the enterprise. At the same time, grid protocols are a way to make single-purpose large servers more accessible and useful to the IT environment as a whole.**

The following factors complicate the situation.

- Enterprise environments have multiple platforms and multiple vintages of servers. Despite open standards, servers on different platforms have different ways of doing things and are limited in their functional cooperation.
- Despite efforts to achieve simplicity, most enterprises still need to do a wide variety of tasks, sometimes accessing the same sources of data.
- Often, enterprise workloads cannot be split into parallel parts.
- The need for interactive access to "real-time" data raises synchronization issues with the replication approach to pervasive access.
- Core applications may have different patterns of processing and pause, depending on which modules are used. These may be affected by other applications providing access via Web Services.
- Different industries have different bottlenecks, and companies have unique ways of dealing with them, which is often a key part of what makes them "tick" operationally.

The commercial enterprise needs a grid that can handle interactive workloads, and it needs to leverage the capabilities of its assets in place. This argues for a *mixed grid* of

Clipper's Glossary of Grid Terminology

Node – *An independent ("stand alone") computing system, capable of executing a single instance of an operating environment across one or more processors.*

Allocated or Virtual Node – *A slice of processing capacity defined without reference to its underlying hardware.*

Multi-node – *A set of independent nodes that exist in the same rack or cabinet (think blade server or SMP server) possibly with some shared architecture and/or management, which is transparent to each internal node.*

- This multi-node could work like a grid-in-a-box or it could be parceled out to different workloads. As a grid-in-a-box, it could use indigenous partition flexibility and workload management to optimize the immediate environment further for the workload at hand.

Mega-node – *A computer system capable of simultaneously hosting several-to-many multi-nodes*. It can be a multiprocessor with soft and hard **partitions** or virtual machines that further fractionalize the partitions.

- A mega-node can be a grid itself or be attached to a grid, sort of a *grid of grids*.

Grid – *A collection of nodes interlinked by a network over which workloads are deployed in order to optimize access to available resources*

Virtual or logical grid – *The virtual nodes available on the Grid, regardless of their physical underpinnings*

Multi-grid – *A network of connected grids*

Grid manager *–Software or a set of protocols (like Globus) that facilitate aggregation, reservation, scheduling, and use of grid computing resources*

Mixed grid – *A grid that contains different kinds of environments (servers and images).* Think "various combinations of chip-based platforms and operating systems" like *Windows/Linux/Solaris* on *Intel/AMD, SPARC*, and *Power* architectures.

heterogeneous servers of different capacities – one that allows an enterprise to deploy workloads that need consistency across homogeneous server domains and also allows use of distinctive nodes for workloads congenial to them.

Rethinking the Grid

Attention needs to switch from the physical assets and their cost at purchase and over time to focus on the workloads and the levels of service (response time, process urgency) they require. By doing so, managing IT becomes much more in synch with the business process that is your mission to support. This is service-centric computing. It is not completely alien; the basic variables are still cost and time.

Make your inventory an inventory of functionality. Virtual machine technology divides even uniprocessor boxes and also individual cores into several discrete virtual servers. With that in mind, rethink what kind of processing you need and how you may most economically achieve it.

With adequate bandwidth, 100 virtual nodes in a single box and 100 nodes of equal functionality on a grid provide the same aggregation and service negotiation (though the points and tools of manageability may be different, and the costs may differ). There is little difference until you need more elasticity. Then a grid of partitions can take advantage of the ability to reallocate more processing capability or memory space on the fly. For this, you need a *mega-node*.

The Virtues of a Mega-node

The more dynamic your business processes, the more you will care about the elasticity and manageability that mega-nodes provide through the following capabilities.

- **Capacity partitioning,** sometimes dynamic, for both hardware and software, with prioritization policies to arbitrate the reallocation. This allows an enterprise to match resources with the task at hand.
- **Virtualization software** for sub-processor partitioning. This increases the granularity of processing that can be assigned to a workload.
- **The ability to schedule and manage workloads** within the node. This allows localized optimization of the different patterns of processor use or multiple workloads.
- **Clustering and internal diagnostics. These** sense processor malfunction and reallocate workloads accordingly, delivering greater resiliency.
- **Open standards** compliance, which is necessary for communications and manageability.
- **Capacity on demand. This** satisfies the need for invokable additional capacity and provides resilience beyond the elasticity of dynamic resource allocation. In automotive terms, it is the spare tire, not the steering and suspension.

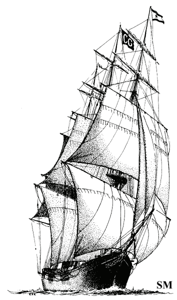
It all comes back to time and money and your workload's characteristics. You may have processes involving real-time data access, where latency hurts and nearness to recipient matters. There may be other processes or parts of processes that can be split into parts and run in parallel to diminish the elapsed time. There may be lower priority processes that can be multiplexed with other critical workloads, but only when there is spare capacity. You will want to take advantage of all of these workload characteristics in your flexible enterprise grid environment.

If you are trying to reduce the costs of computing to your users, you can no longer afford to think just about the physical assets. But you cannot ignore them either. Your applications may care about the processor, the server firmware, the middleware, the resource management, and the capabilities and resilience of the operating system in order to get the most bang for the buck from each node. What physical servers you choose to deploy in your grid will depend on your need for responsiveness, your concerns about security, the kinds of workloads that need to be run, and, of course, your ability to buy new capital assets. **The on-the-fly flexibility characteristics of multi-node and mega-node servers to work as nodes in your grid may be the ultimate determinant because every unused cycle becomes a source of unrecoverable loss.**

An opportunity is knocking on the door of the beleaguered enterprise. The benefits of and need for enterprise grids go far beyond the economics of capacity utilization. **By changing your perspective from *managing physical assets and running applications on them* to *managing and deploying workloads on your collection of physical assets*, you will give the enterprise the flexibility needed to be responsive to today's rapidly evolving markets.**

Conclusion

Grid architecture gives to the IT infrastructure managers new tools for consolidation and cost control of commercial enterprises. More importantly, it gives new tools for optimizing the performance of the applications that support the enterprise. **The inclusion of the mega-node in a grid allows core enterprise applications to participate in and add benefits to grid architectures.**



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