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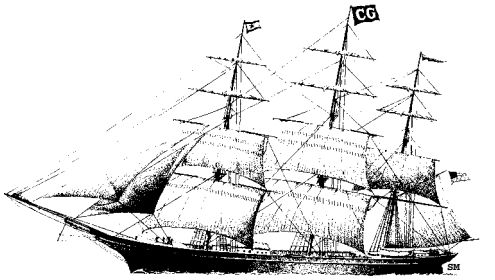

Navigating Information Technology Horizons℠

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Understanding the Role of IT Virtualization — It's a Matter of Architecture

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Management Summary

Over the past few years, IT virtualization has grown from an arcane mainframe technique to a buzzword, and finally to a pervasive capability, but its definition continues to be a great source of confusion. The security-focused folks often think of server virtualization as *isolating* containers to keep each workload safe from the effects of other workloads – and even to keep the native OS safe from the depredations of the container contents. Network-oriented people often think of storage virtualization as *aggregating* capacity into bigger, more sharable pools. The throughput-obsessed optimizers see the multiplexing of all kinds of virtualization, with prioritizing policies, as the way to get the most out of IT assets – a hardware *consolidation* play. Each of these explanations is correct in their own way, but insufficient. Taken together, they can be puzzling.

It helps to stop thinking of virtualization as a hardware-oriented concept, even though it is often part of a hardware discussion. Instead, **start thinking of virtualization as an IT management tool – a tool of abstraction and delegation.** Consider the order entry register at a fast foods restaurant, which, to minimize errors and speed service, is keyed by the menu item, rather than numerically. When a restaurant is serving a few dozen restaurant patrons a day, this translation tool may not contribute greatly to improved efficiency. When it serves thousands, the speed and ease of the optimized tool is key to accurate orders and fast delivery. Moreover, it can also support inventory control and analysis of staffing levels. With specifics of price abstracted under the cheeseburger key, price changes, special value meals, and time-of-day discounts can be instituted by re-programming the key functions, without having to alert or educate the order takers. With a sophisticated system, the restaurant can optimize operations in ways not previously possible.

Similarly, in IT systems, virtualization uses standard specifications and mapping to recast IT infrastructure (mostly hardware) as a callable asset. The immediate benefits are like the first-order benefits of the cheeseburger key – but it is the second and third order benefits that make the technology of virtualization truly exciting. **For the data center, virtualization allows compute assets to be assembled by need and not by permanent assignment**. Virtualization creates a managed, logical-level compute zone that can be reprogrammed (like those key functions) without affecting the system as a whole, affording easier system evolution. And, because virtualization elements are software, they can be stored for reuse or replicated as spares for logical-level redundancy. And, ultimately, the enterprise can optimize its use of hardware assets to further revenue opportunities and competitive advantage with less disruption.

To take advantage of the full benefits of what IT asset virtualization has to offer, how IT is managed must be reorganized. The tools are not unfamiliar, but their use has expanded. For more details, read on.

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The Role of Architectures

The role of architecture in organizations and their IT structures is not unlike the role of architecture in building construction. **The first priority of architecture is *to optimize what you do where* (in the case of organizations, who does what)**. However, architectures serve not just to keep the rain off and to keep cooking smells from pervading the bed-sheets. **There is a second architectural imperative – *to channel risks so that they can be met on your terms*.** Medieval castles, for example, had moats and portcullises to limit sources of attack and decrease the rate of encroachment, and switch-back entries to limit the utility of battering rams.

While modern domestic architectures don't focus on the risk-channeling imperative of architecture, business architectures do. The structure of partnerships and marketing, and the deployment of a sales force have more to do with the nature of the competition than with the fads of organizational paradigms. IT architectures have been mostly concerned with the domestic issues of security and meeting the demands of their users. Now, increasingly, IT is being used as a strategic and competitive asset.

Over time, airplanes and long-range missiles rendered castles and other similar fortifications obsolete. **In general, it is usually not the evolution of architectural elements that makes an architecture ineffective (fashion is another matter), but changes in *how the structure is used*. Changes in the risks that architectures were designed to address are an even more powerful agent of change.** And, like the evolution of warfare over the centuries, business competitive strategies are changing.

For enterprises, the Internet is the airplane that made castles and traditional coastal fortifications obsolete. With the Internet, customer support (or lack thereof) becomes a topic in chat rooms. Product popularity and unpopularity can both blossom rapidly, and either can be fatal to an organization not prepared for both eventualities. The Internet has made every customer a global shopper and every partner more accessible to competitors. Loyalty cannot be presumed, but must be supported. Economic reality may often dictate that support for irregular customers and weak partners are a luxury the enterprise cannot afford.

The challenges of selling to, and finding, new customers in such markets have changed the structure of enterprises – and they have profoundly changed what enterprises demand of their IT systems. (See Exhibit 3 on the next page). Opportunities such as supply chain integration, whose productivity benefits cannot be ignored, routinely expose IT systems to threats and demands from the outside world. The trend to partner for a complete solution adds the need for inter-organizational collaboration.

To address these needs, IT architectures have evolved from environments optimized for internal operations, easily represented by layered blocks of functionality and skeletons of asset relationships, to jack-of-all-trades environments optimized for erratic, customer-facing uses which must interface with an expanding variety of routine processes. This changes old, fixed-use IT architectures into portcullises that, while still important, may not fully meet the needs of the enterprise. Enterprises need internal security (more doors) because now there are fewer human checks and balances to curb malfeasance. They need the IT equivalent of vestibules to deal with partners – some huge and potentially tyrannical – with whom they do not want to share more than is necessary. They need flexible walls because, on occasion, opportunities blossom which must be met immediately. Moreover, they need extensive analytics to predict what will be needed and to model what might be possible.

Meanwhile, economics have upped the need for data center cost-justification and shortened the period in which results must be produced. In addition, like the fast food keyboard that once seemed designed to cope with stupidity, **tools that can optimize business process throughput now have a very high and multi-dimensional value.**

The Architectural Role of Virtualization

IT virtualization is like the transition from frame to balloon construction. In traditionally framed houses, the structure depends on both external and internal load-bearing walls. This limits the arrangement and size of rooms and the ability to remodel. With balloon construction, there are no internal load-bearing walls and rooms can be sized to suit their use. Similarly, with IT virtualization, you can isolate, pool, and consolidate compute elements – but, above all, you can change your allocations easily.

Exhibit 1 – Types of Containers

Permanent Containers

- Hardware partitions, switch ports
- Software (logical partitions)

Aggregated containers

- Concatenated disks
- Trunked switch ports

Temporary containers

- Software constructs of various types known by a number of names including storage volumes, virtual (server) machines, and (application) run-times. All aggregate components in relationships, segregate them from external threats, and allow them to be managed and optimized as a set. These temporary containers are distinguished by their functionality. (See Exhibit 2.)

In processor virtualization, applications get defined as, or run in, software containers, such as virtual machines, whose definition decrees, and workload management insures, that the appropriate resources are given according to the assigned priority. These containers, like the bulkheads on a ship, can limit the vulnerability of the system as a whole, and can, in some cases, implement a zone of higher security where it is needed, without unnecessarily burdening the system as a whole. Depending on their nature and functionality (see Exhibits 1 and 2, above), these containers can share resources and enable the data center to do more with less.

Storage virtualization allows IT management to create the conceptual container (LUN) that applications need to put data in from a pool of storage of acceptable quality, without assigning specific disk space. Network virtualization, like its server and storage counterparts, sets up logically defined sub-networks that allow multiple applications to share the copious bandwidth safely.

In all cases, **virtualization creates a buffer layer. This layer, like the presentation layer that greets an end user no matter what device s/he is using, satisfies all parties while allowing a space for business policies to increase utilization and reduce the cost of computing.**

Exhibit 2 – Container Functionality

- **Emulators** that map expectations to reality.
- **Masks** that constrain antisocial behavior while allowing useful interaction with the larger environment.
- **Envelopes** that protect applications from outside influences, allowing safe application multi-tenancy on a chip or on an operating system.

The Ramifications of Virtualization

Managing a system of containers deployed across pools of resources is different from managing a system of devices optimized for batch or constant use. While change is easier, control must be rethought. As anyone who has shared a multi-purpose living space with family or roommates knows, when everyone is generally but unpredictability busy, hard-and-fast job assignments work less well than general specifications and shared tasks. Because this latter approach does not preclude conflict completely the way job assignments did, conflict resolution strategies must be built into the domestic arrangement.

The situation is similar in IT environments, where composite apps, self-service opportunities, and Web Services cause unpredictable resource demands. The real-time flexibility of virtualization is the approach that affords most affordably the least constraints to revenue producing applications. So let's look at how you manage it.

Policies

Multiple sets of policy specifications set the stage for promiscuous application tenancy in the data center. Today we are beginning to set priority and quality of service policies for applications based on their business use. With virtualized compute elements, we need another tier of policies to map application requirements (which are based on priority policies) to physical-level needs. At the physical level, the sense-and-respond self-management of autonomic health provides a third level of metrics that must be part of the optimization scheme if the find-and-bind opportunistic style of virtualized computing is to work. While the

Exhibit 3 - How the Role of Enterprise IT Has Changed

Original IT Imperatives

- **Protect** the system from failure. Test thoroughly, architect redundancy, dissipate heat, lock the door, and make IT transparent so end users can't wreck it.
- **Optimize** performance and throughput by optimizing utilization of limited elements (processing and memory).

Now Come the Agents of Change

- IT's ability to **accelerate routine administrative functions** expanded its use in the enterprise to many applications linked, for efficient use of common assets, on a network.
- The human predilection for **client-side, real-time responsiveness** and the expense of telecommunication costs promoted decentralization of assets, which begat server and software sprawl.
- **Security** then became more than walls and, then, more than Firewalls and DMZs, adding intrusion tracking, honey-pots, and more. The arsenal is extensive, quickly evolving, and precipitated throughout the environment.
- **Internal and external collaboration** (marketplaces, whiteboards, and composite applications) **boosted operational efficiencies**, but brought up issues of privacy, digital rights, and process "ownership," which, in turn, begged for new metrics and controls. Management by end-user experience demanded coordination of application, system, and storage management became important. The need to access to diverse data sources challenged the application-bound nature of data, and drove a need for larger-scale constructs like global file systems.

While at the Same Time

- **Processing and memory became more plentiful**, abating the need to optimize for their use, and challenging administrators to optimize for 24x7 system availability,
- **Clustering and failover and device health metrics allowed device failure to degrade, not disable, a system**, challenging administrators to optimize for real-time responsiveness.

and, thus, a New Mandate is Developed

- **Protect the system from failure**. Use massive redundancy, pervasive security, ample bandwidth, and standardization tactically to deliver a guaranteed quality of service. Environmental concerns like heat are still a problem. Use detailed metrics and modeling to react quickly to new opportunities.
- **Optimize the use of the system to support desired functionality**. The profile of business risks that must be ameliorated may dictate the acceptance of some IT risks, which can be mitigated by technology.

three tiers may seem complicated, it is the tiering that changes automation from a tyrannical lockstep into a docile power assist. The human roles will be moved from monitoring the alerts to modeling policy trees to make sure that business priorities are optimized and risks are mitigated. Interestingly, low-priority, utility processes, which may be degraded, are a key to providing the resilience to deal with sudden, high-priority spikes.

The Power to Move: Clustering and Load Balancing

If a system has the autonomics to know when a device is failing, and the grid-computing protocols to resituate the virtual element (which will have the identity to maintain its relationship with other compute elements), both failover and the traditional tweaks of load balancing can be supported. A new kind of automated, logical level system resilience is possible. This does not replace the need for a degree of redundancy at the physical level, but it augments the response options to device failure and application failure.

Metrics and Fault Isolation

The rate of change fostered by virtualization demands real-time metrics to determine what is

going on and to trace any error accurately to its cause. Hardware metrics alone will not do. Application metrics must also be included, and metrics for Web Services if they are used. These metrics must be comprehensively gathered, scrupulously organized, and analyzed according to the current functional aggregations of assets, and the messaging lightweight[1]. Effective control of virtualized assets spans realms of IT administration that have traditionally been so separate that even their taxonomies of terms were not congruent, and there is work to be done to make the tiers of policies and metrics work together to support both fault isolation and optimization Still, products to manage these spaces have rapidly appeared. With open standards, the integration of appropriate tools and the maturation of console and controls should happen quickly. It is, after all, a competitive market.

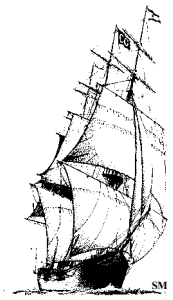
Performance Considerations

The use of virtualization does add another bulk of software to be supported and another layer to the management stack. Overall, virtualization requires a rethink on several fronts. Virtualization is something that was seldom appropriate in an era of resource scarcity, but has become highly useful in an era of rampant and unruly demand. However, times have changed. The role of IT in enterprise has changed. The risks that businesses face may be the same as in years past, but there are new vulnerabilities and dimensions of attack to be defended. Moreover, while defense is still critical, defense alone does not assure survival. More importantly, a siege mentality will leave a lot of opportunity on the table. To address markets in a timely and well-targeted way, deft use of analysis, marketing, and customer facing channels is mandatory. Now that processing and memory are plentiful in the data center and increasingly affordable to smaller businesses, **virtualization gives enterprises a way to trade their surplus cycles for the ease of change they really need.**

Conclusion

The need to speedily deploy the weapons and lures of business has always been great. These days, those weapons contain a hefty dose of technology, and often hook into a prodigious variety of enterprise IT assets. Virtualization, like the cheeseburger key, reduces the need for technological expertise to manage and deploy these assets. Prodigious opportunities await those with the foresight to address opportunities in a timely fashion.

Shunning virtualization is no longer a responsible strategy. (See, again, Exhibit 3.) **Learning to use the tools of virtualization well, and reorienting management to facilitate its use, is more productive**. This will be a gradual transformation, and its path will depend on where you need the spot flexibility that virtualization can give the enterprise.



The ivory towers of the castles of the past, with their moats and portcullises, are now tourist attractions. Data Centers make lousy tourist attractions. It is time to include virtualization in your planning assumptions.

[1] Standardization of event notification will help here.

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