CLOUD COMPUTING AS A DISRUPTIVE TECHNOLOGY

By Alex Krikos
Cloud computing has gained traction in the marketplace, but the idea of creating a scalable and flexible shared computing solution via the Internet has been around for more than a decade. Today, cloud computing is steadily replacing more rigid software and services licensing models, thanks both to an improvement in technological capabilities and to changes in marketplace demands.
In my own research on cloud computing business models, I considered how on-demand and utility-based computing resources have been used in the past. In the late 1990s, Hewlett-Packard and Dell used their expertise in workstations, servers, storage, and I/O to host applications in a network-based and time-shared environment. What was lacking was a sophisticated, three-tiered framework of building blocks to manage data centers, develop applications and platforms, and deploy applications and services. These building blocks have become the foundation of cloud computing.

Today, cloud computing has all the markings of a disruptive technology — those that change the game as it’s currently played both by traditional software licensing companies and by private, on-premises data centers. At first glance, a disruptive technology might be thought of as a bad thing. But it’s really not. A disruptive technology is only a threat to incumbent businesses and customers, and those organizations in R&D, marketing, and finance that are beholden to exclusively support these incumbent businesses and customers. A disruptive technology flies under the radar, opening new markets, products, and services at returns that are initially unattractive to the incumbents. The drawbacks in the so-called public cloud include security, compliance, open standards, and enterprise IT control.

DEFINING CLOUD COMPUTING AS DISRUPTIVE TECHNOLOGY

To analyze whether cloud computing could be considered a disruptive technology, I tested three criteria as developed by Harvard Business School Professor Clayton Christensen in “The Rules of Innovation.” The first two rules focus on the markets that cloud computing impacts, and the third centers on the ecosystems that support its success.

1. Cloud computing as an innovation must enable less skilled and/or less wealthy individuals to receive the same utility as was previously available only to more skilled and/or more wealthy individuals.

2. Cloud computing must target customers at the low end of a market with modest demands on performance. However, it must do this with a performance trajectory capable of exceeding those demands and take over markets tier by tier. As a corollary to this second criterion, the cloud computing business model needs to allow the disruptive innovator to achieve attractive returns at prices that are unattractive to the incumbents.

3. Cloud computing must be supported by an ecosystem structured as either a fully integrated end-to-end entity or a set of nodular, niche entities.

The behavior of a disruptive technology is captured in Figure 1 below. Market demand, expressed in terms of technological performance, is plotted as a function of time. In this figure, the market’s ability to absorb a given technology or service is shown by the shaded region bounded by the high-end and low-end of customer demand. The incumbent technology has its own performance trajectory. Once this performance trajectory exceeds the high-end of market demand, it outstrips the market’s ability to absorb it as shown in Figure 1. At this point, the incumbent technology becomes vulnerable to disruptive technologies as described by the first two criteria above. The disruptive technology emerges at a lower performance point with a commensurately lower cost, but is armed with a performance trajectory capable of overtaking markets tier by tier. Ultimately, the disruptive technology will outstrip the market’s ability to absorb it, and the cycle repeats itself with a new, emerging disruptive technology. Christensen observed this behavior in the disk-drive industry, where a succession of architectural changes from the 14-inch drive all the way to the 1.8-inch drive created new markets and also left the incumbent firms, unwilling and unable to foster these changes, as shadows of their former selves. Architectural changes in cloud computing serve the same purpose — opening new markets to a new consumer base.

DEFENDING CLOUD COMPUTING AS DISRUPTIVE TECHNOLOGY

As shown in Figure 2 below, cloud computing emerges as disruptive technology when the evolution in traditional software licensing and premises-based data center technologies outstrips the market’s ability to absorb it. While there is currently no single industry-accepted and composite performance metric for the software and services domain, the constituent elements include: security, cost, application management and performance, ease-of-use, scalability, and enterprise IT control.
Christensen had chosen areal density as a performance metric in the disk-drive industry. In cloud computing, the market segmentation is sufficiently detailed to warrant specific performance metrics instead of a weighted, composite average. Figure 2 diagrams the strengths, weaknesses, opportunities, and threats (SWOT) that define the incumbent software licensing and premises-based data center landscape along with emerging disruptive cloud-based solutions.

I arbitrarily placed the competitive landscape and SWOT as of 2009 for the incumbent SW licensing and premises-based data center solutions at the high end of customer demands, where performance is sufficiently high to outstrip market demand. This is where the incumbent technologies are most vulnerable to disruptive threats.

Starting at the top left of Figure 2, the incumbents’ strengths include high levels of security, compliance, and enterprise control. However, the traditional SW license and premises-based data center model is vulnerable to highly scalable, low-cost cloud computing providers. The emergent cloud computing disruptive technology at the bottom left of the figure has strengths in scalability, virtualization, and low-cost, utility-based pricing. While it has drawbacks in the areas of security, enterprise control, and open standards, cloud computing is a disruptive technology because it not only offers low-cost solutions at lower initial performance levels, but also has a performance trajectory capable of meeting and exceeding market demands over time. This is shown at the upper right of the figure, where improvements in cloud computing performance may outstrip the market’s ability to absorb it. Only time will tell.

In the future, cloud computing is likely to make significant gains in security, compliance-rich applications, and configuration management, which are essential requirements of an enterprise-grade cloud. However, IT enterprise control will probably remain a significant weakness as the cloud engenders third-party control. It is also likely that the cloud computing landscape will be fraught with competition between single end-to-end solution providers and the individual modular firms that make up its ecosystem.

The performance trajectories of cloud computing and the market’s ability to absorb them, while notional, are expected to increase over time as mod-
ular firms such as 3Tera, VMware, and Citrix push the performance envelope for open standards and virtualization. However, even as cloud computing takes hold as the dominant computing paradigm, it can be expected that this technology will once again outstrip the market’s capability to absorb it — leading to new disruptive technologies. For example, as applications in the public cloud come under increasing scrutiny in the security and compliance arenas, hybrid clouds and new configuration management tools are likely to emerge as a new disruptive technology.

Component and architectural improvements in cloud computing play a vital role in the definition of performance metrics, along with the construction of the so-called S-Curve (Christensen, 1992). Specifically, architectural changes have relevance in determining which elements of cloud computing lead to competitive advantage along with a first-mover advantage. Along the vein of Christensen’s research in disk drives, architectural changes in cloud computing -- including enhanced virtualization, hybrid networks, and open standards -- will lead not only to competitive advantage but also to predictive performance improvements within the cloud computing S-Curve.

Cloud computing satisfies the three market and ecosystem criteria outlined above for disruptive technologies. First, the inception of the public cloud and its next-generation advances in hybrid cloud technologies allow those with modest means to secure the same computing services that only those with greater means could formerly obtain. Second, the public cloud and its evolutionary improvements target the low end of the market, at an initial reduction in performance, but with a performance trajectory capable of meeting and exceeding market demands. In addition, firms using emergent disruptive technologies are able to make attractive returns at prices unattractive to incumbents. This is a consequence of the cloud’s value proposition of shared environments, which defray costs among a large subscriber base. Third, cloud computing has an ecosystem emblematic of a true disruptive technology. Leaders in cloud computing have been represented by fully integrated, end-to-end solution

![License-Driven SW, Premise/Internal-Based Data Centers](image)

**Figure 2:** The shaded band represents the range of customer demands, which rises over time. The public cloud initially emerges at lower performance, but has a performance trajectory characteristic of a disruptive technology, taking over markets tier by tier.
providers and by a collection of niche, modular firms. These modular firms are more likely to invent and advance the more revolutionary architectural S-Curve changes in cloud computing.

INDUSTRY & DISRUPTIVE CLOUD TECHNOLOGY

Now that cloud computing has been established as a disruptive technology, what should industry know to incubate this technology? Also, how can industry spot a disruptive cloud computing technology? Here are five thoughts.

1. Define Architectural Versus Component Improvements: Industry should pay attention to “architectural” advances in virtualization, security, compliance, and open standards. These advances give rise to a first-mover advantage for new markets that have been traditionally overlooked by established and sustaining businesses in the public cloud. Improvements in connectivity, bandwidth, and latency are considered “component” changes, which mostly serve to benefit sustaining businesses and customers, although one could argue that memory-intensive and technical computing applications may get a stronger foothold with network improvements.

2. Create a Disruptive Framework: Cloud computing end-to-end and niche providers should take a counterintuitive approach to incubating new cloud computing technologies. They should not compare emergent disruptive cloud computing technologies to the incumbent technology. Rather they should compare the disruptive technology to what the market needs and what it can absorb. Any initial reduction in performance will be overtaken by a performance trajectory capable of meeting and exceeding market demand over time. The key point is that new markets will emerge. In many cases, the disruptive technology will overtake the performance of the incumbent technology.

3. Look Who’s Paying Attention: If operations within an established company are excited about a new cloud computing idea, make sure that those operations including R&D, marketing, finance, etc. aren’t exclusively beholden to sustaining technologies and customers. More often than not, these operations and their attendant cost structures are focused on incremental improvements to meet the needs of established businesses. This behavior does not foster the emergence of new markets and the enablement of customers who were not formerly able to participate in cloud computing.

4. Discover Firms That Foster Architectural Improvements: In defining the competitive landscape for end-to-end cloud computing providers, suppliers and buyers can forward-integrate and reverse-integrate into that space respectively. However, they will covet the same established businesses and customer base as the incumbents. Typically, they do not drive toward disruptive technologies in the cloud. Niche providers including new entrants and low-cost substitutes are more likely to incubate disruptive technologies in the security, compliance, and open standards arena. Cloud computing ecosystems constructed of niche providers are more likely to develop architectural improvements and, in turn, disruptive technologies.

5. Reinvest in Enterprise IT Control: Enterprise IT control is dominant in private data center and co-location solutions. It becomes less dominant in the public cloud, dedicated hosting, and managed hosting. This is a sticking point for IT organizations that are relegated to craft SLAs to establish some semblance of control. It would behoove third-party cloud computing providers to relinquish a greater portion of IT control in the form of configuration management tools.

CONCLUSION

The future of cloud computing is moving toward more ubiquity, as greater demands from customers and greater capabilities from providers unfold. There are a number of market drivers that are orthogonal to the more well-known advantages of cloud computing. Most of these market drivers focus on the rise of entrepreneurship. In the next decade, the number of baby boomers will vastly increase to the point that entrepreneurial opportunities will be more feasible than corporate ones. Demographics that are more partial to entrepreneurship will play a vital role in the adoption of cloud computing. Cloud computing will be a catalyst to entrepreneurship — lowering both cost and logistical barriers to entry, as well as ushering in a new era of scalable businesses ranging from financial services to healthcare. Cloud computing providers shouldn’t rest on their laurels of scalable, virtualized, and utility-based solutions. It would behoove the astute cloud computing provider to incubate separate business units that address disruptive technologies in the areas of security, compliance, configuration management, enterprise IT control, and open standards, which had formerly excluded low-end markets.