Software in Flux: Free and Cloudy

Last modified: March 8, 2009 (draft version: comments very much welcomed)
Note: this is an earlier version of the chapter. All chapters updated after July 2009 are now hosted (and still free) at http://www.flatworldknowledge.com. For details see the 'Courseware' section of http://gallaugher.com

INTRODUCTION

For many, software has been a magnificent business. It's the $200 billion a year juggernaut[1] that placed Microsoft's Bill Gates and Oracle's Larry Ellison among the wealthiest people in the world. Once a successful software product has been written, the economics for a category-leading offering are among the best you'll find in any industry. Unlike physical products assembled from raw materials, the *marginal cost* to produce an additional copy of a software product is effectively zero. Just duplicate, no additional input required. That leads to businesses that can gush cash. Microsoft generates a $1.5 billion a month from Windows and Office, alone[2]. Network effects and switching cost can also offer a leading software firm a degree of customer preference and lock in that can establish a firm as a standard, and in many cases creates winner-take-all (or at least winner-take-most) markets.

But as great as the business has been, the fundamental model powering the software industry is under assault. *Open source software* offerings – free alternatives where anyone can look at and potentially modify a program's code – pose a direct challenge to the assets and advantages cultivated by market leaders. Giants shudder – "how can we compete with free", while others wonder "how can we make money and fuel innovation on free"? And if free software wasn't enough of a shock, the way firms and users think about software is also changing. A set of services referred to as *cloud computing* is making it more common for a firm to move software out of its own IS shop, so that it is run on someone else's hardware. In one variant of this approach known as *software-as-a-service* (*SaaS*), users access a *vendor's software* over the Internet, usually by simply starting up a web browser. With SaaS, you don't need to own the program or install it on your own computer. Hardware clouds can let firms take *their software* and run it on someone else's hardware – freeing them from the burden of buying, managing, and maintaining the physical computing that programs need. Another software technology called *virtualization* can make a single computer behave like many separate machines. This helps consolidate computing resources and creates additional savings and efficiencies.

These transitions are important. They mean that smaller firms have access to the kinds of burly, sophisticated computing power than only giants had access to in the past. Startups can scale quickly and get up and running with less investment capital. Existing firms can leverage these technologies to reduce costs. Got tech firms in your investment portfolio? Understanding what's at work here can inform decisions you make on which stocks to buy or sell. If you make tech decisions for your firm or make recommendations for others – these trends may point to which firms have strong growth and sustainability ahead, or which may be facing troubled times.

[1] Kirkpatrick, 2004
[2] Vogelstein, 2006

KEY TAKEAWAYS

- The $200 million+ software business is attractive due to near zero marginal costs and an opportunity to establish a standard – creating the competitive advantages of network effects and switching costs
- New trends in the software industry, including open source software, hardware clouds, and Software as a Service, and virtualization are creating challenges and opportunity across tech markets. Understanding the impact of these developments can help a manager make better technology choices and investment decisions.

OPEN SOURCE:

Who would have thought a 21 year old from Finland could start a revolution that continues to threaten the Microsoft Windows juggernaut? But Linus Torvalds did just that. During a marathon 6 month coding session, Torvalds created the first version of Linux[3] marshalling open-source revolutionaries like no one before him. Instead of selling his operating system, Torvalds gave it away. Now morphed and modified into scores of versions by hundreds of programmers, Linux can be found just about everywhere, and most folks credit Linux as being the most significant product in the open source arsenal. Today Linux powers everything from cell phones to stock exchanges, set top boxes to supercomputers. You'll find the OS on 30 percent of the servers in corporate America[4], and supporting most web servers (including those at Google, Amazon, and Facebook). Linux forms to core of the TiVo operating system, the Android mobile phone system, and it has even gone interplanetary. Linux has been used to power the Phoenix lander and to control the Spirit and Opportunity Mars rovers[5]. Yes, Linux is even on Mars!

How do you pronounce Linux?

Most English speakers in the know pronounce Linux in a way that rhymes with '*cynics*'. You can easily search online to hear video and audio clips of Linus (whose name is actually pronounced 'Lean-us' in Finish) pronouncing the name of his OS. In deference to Linux, some geeks prefer something that sounds more like '*lean-ooks*[6]'. Just don't call it '*line-ucks*', or the tech-savvy will think you're an open-source *n00b*! Oh yeah, and while we're on the topic of operating system pronunciation, the Macintosh operating system OS X is pronounced "oh es ten".

Tux, the Linux Mascot

Open source software (*OSS*) is often described as free. While most open source software can be downloaded for free over the Internet, it's also 'free' as in liberated. The source code for open source products is openly shared. Anyone can look at the source code, change it, and even

[3] Diamond, 2007
[4] Lacy, 2007
[5] Brockmeier, 2004; Barrett, 2008
[6] For examples, see: http://mostlylinux.ca/pronounce/torvalds-says-linux.wav and http://suseroot.com/about-suse-linux/how-do-you-pronounce-linux.php

redistribute it, provided the modified software continues to remain open and free[7]. This is in stark contrast to conventional software firms, who treat their intellectual property as closely guarded secrets, and who almost never provide the source code for their commercial software products. At times, many software industry execs have been downright hostile toward OSS. The former President of SAP once referred to the open source movement as 'socialism', while Microsoft's Steve Balmer has called Linux a 'cancer'[8].

But while execs at some firms see open source as a threat undermining the lifeblood of their economic model, other big-name technology companies are now solidly behind the open source movement. The one-time notion of open source being fueled on the contributions of loners tooling away for the glory of contributing to better code is now largely inaccurate. The vast majority of people who work on efforts like Linux are now paid to do so by commercially-motivated employers[9]. Nearly every major hardware firm has paid staff contributing to open source projects, and most firms also work together to fund foundations that set standards and coordinate the release of product revisions and improvements (for example, to try to ensure all of this version of Linux work alike). Sun claims to have 11,000 engineers contributing to open source[10]. Guido van Rossum, the inventor of the open source Python programming language, works for Google where he continues to coordinate development. IBM programmers work on several open source projects, including Linux. The firm has even deeded a commercially developed programming tool (including an *IDE*) to the Eclipse foundation, where it's now embraced and supported by dozens of firms.

Turn on the LAMP – it's free!

Open source is big on the Web. In fact, you'll often hear web programmers and open source advocates refer to the LAMP stack. LAMP is an acronym that stands for the Linux operating system, the Apache web server software, the MySQL database, and any of several programming languages that start with the letter 'p' – perl, python, and PHP. From Facebook to YouTube, you'll find LAMP software powering many of the sites you visit each day.

KEY TAKEAWAYS

- Open source software is available for free, but also makes source code available for review and modification (for the Open Source Initiatives list of criteria the defines an open-source software product, see: http://opensource.org/docs/osd).
- While open source alternatives are threatening to conventional software firms, some of the largest technology companies now support open source software initiatives and work to coordinate standards, product improvements, and official releases.

[7] A list of criteria defining open source software can be found at the Open Source Initiative at opensource.org
[8] Fortt, 2007
[9] Woods, 2008
[10] Preimesberger, 2008

- The flagship open source software product is the Linux operating system, now available on all scales of computing devices from cell phones to supercomputers. The LAMP stack of open source products is used to power many of the Internet's most popular websites.

WHY OPEN SOURCE?

There are many reasons why firms choose open source products over commercial alternatives. Among these:

- *Cost*: Free alternatives to costly commercial code can be a tremendous motivator, particularly since conventional software often requires customers to pay for every copy used, and to pay more for software that runs on increasingly powerful hardware. Big Lots stores lowered costs by as much as $10 million by finding viable open source software[11] to serve their system needs. Online broker E*Trade estimates that its switch to open source helped save over $13 million a year[12]. And Amazon claimed in SEC filings that the switch to open source was a key contributor to nearly $20 million in tech savings[13]. Firms like TiVo, that use open source software in their own products, eliminate a cost spent either developing their own operating system, or licensing similar software from a vendor like Microsoft.
- *Reliability*: There's a saying in the open source community "*Given enough eyeballs, all bugs are shallow*"[14]. What this means is that the more people who look at a program's code, the greater the likelihood that an error will be caught and corrected. The open source community harnesses the power of legions of geeks who are constantly trawling OSS products, looking to squash bugs and improve product quality. And studies have shown that the quality of popular OSS products outperforms proprietary commercial competitors[15]. In one study, Carnegie Mellon University's Cylab estimated the quality of Linux code to be less buggy than commercial alternatives by a factor of 200[16]!
- *Security*: OSS advocates also argue that by allowing "many eyes" to examine the code, the security vulnerabilities of open source products come to light more quickly and can be addressed with greater speed and reliability[17]. High profile hacking contests have frequently demonstrated the strength of OSS products. In one well-publicized 2008 event, laptops running Windows and Macintosh were both hacked (the latter in just two minutes), while a laptop running Linux remained uncompromised[18]. Government agencies and the military often appreciate the opportunity to scrutinize open source efforts to verify system integrity (a particularly sensitive issue among foreign governments leery of legislation like the USA Patriot Act[19]). Many open source vendors offer 'security focused' (sometimes called 'hardened') versions of their products. These can include systems that monitor the integrity

[11] Castelluccio, 2008
[12] King, 2008
[13] Shankland, 2001
[14] Raymond, 1999
[15] Ljungberg, 2000
[16] Castelluccio, 2008
[17] Wheeler, 2003
[18] McMillan, 2008
[19] Lohr, 2003

of an OSS distribution, checking file size and other indicators to be sure that code has not been modified and redistributed by bad guys who've added a back-door, malicious routines, or other vulnerabilities.

- *Scalability*: Many major OSS efforts can run on everything from cheap commodity hardware to high-end supercomputing. This allows a firm to scale from startup to blue chip without having to significantly re-write their code, potentially saving big on software development costs. Not only can many forms of OSS be migrated to more powerful hardware, packages like Linux have also been optimized to balance a server's workload among a large number of machines working in tandem. Brokerage firm E*Trade claims that usage spikes following 2008 U.S. Federal Reserve moves flooded the firm's systems, creating the highest utilization levels in five years. But E*Trade credits its scalable open source systems for maintaining performance while competitors' systems struggled[20].
- *Agility and Time to Market*: Vendors who use open source software as part of product offerings may be able to skip whole segments of the software development process, allowing new products to reach the market faster than if the entire software system had to be developed from scratch, in-house. Motorola has claimed that customizing products built on open source software has helped speed time-to-market for the firm's mobile phones, while the team behind the Zimbra e-mail and calendar effort built their first product in just a few months by using some 40 blocks of free code[21].

TRY IT: What's That Site Running?

The website NetCraft (www.netcraft.com) is one of many that provide a tool to see the kind of operating system and web server software that a given site is running. Visit NetCraft or a similar site and enter the address of some of your favorite websites. How many run open-source products (e.g. the Linux OS or Apache web server)? Do some sites show their software as 'unknown'? Why might a site be reluctant to broadcast the kind of software that it uses?

KEY TAKEAWAYS:

- The most widely cited benefits of using open source software include: low cost, increased reliability, improved security and auditing, system scalability, and helping a firm improve its time to market.

EXAMPLES OF OPEN SOURCE SOFTWARE:

Just about every type of commercial product has an open-source equivalent. SourceForge.net lists over 150,000 such products! Many of these products come with the installation tools, support utilities, and full documentation that make them difficult to distinguish from traditional commercial efforts[22]. In addition to the LAMP products, some major examples include:

- Firefox: a web browser that competes with Internet Explorer.
- OpenOffice: a competitor to Microsoft Office

[20] King 2008
[21] Guth, 2006
[22] Woods, 2008

- Gimp: a graphic tool with features found in Photoshop
- Alfresco:collaboration software that competes with Microsoft Sharepoint & EMC's Documentum.
- Marketcetera:an enterprise trading platform for hedge fund managers that competes with FlexTrade and Portware.
- Zimbra:open source e-mail software that competes with Outlook server.
- MySQL, Ingres, and EnterpriseDB:open source database software packages that each go head-to-head with commercial products from Oracle, Microsoft, Sybase, and IBM.
- SugarCRM:customer relationship management software that competes with Salesforce.com and Siebel.
- Asterix:an open source implementation for running a PBX corporate telephony system, that competes with offerings from Nortel and Cisco, among others.
- Free BSD and Sun's OpenSolaris:open source versions of the Unix operating system.

KEY TAKEAWAYS

- There are thousands of open source products available for nearly every software category. Many have a sophistication that rivals commercial software products.
- Not all open-source products are contenders. Less popular open source products are not likely to attract the community of users and contributors necessary to help these products improve over time (again we see network effects are a key to success – this time in determining the quality of an OSS effort).

WHY GIVE IT AWAY? THE BUSINESS OF OPEN SOURCE

Open source is a $60 billion industry[23], but it has a disproportionate impact on the trillion dollar IT market. By lowering the cost of computing, open source efforts make more computing options accessible to smaller firms. More reliable, secure computing also lowers costs for all users. OSS also diverts funds that firms would otherwise spend on fixed costs, like operating systems and databases, so that these funds can be spent on innovation or other more competitive initiatives. Think about Google, a firm that some estimate has over 1.4 million servers. Imagine the costs if it had to license software for each of those boxes!

Commercial interest in open source software has sparked an acquisition binge. Red Hat bought open source application server firm JBoss for $350 million. Novell snapped up SUSE Linux for $210 million. And Sun plunked down over $1 billion for open source database provider MySQL[24] (see box).

But how do *vendors* make money on open source? One way is by selling support and consulting services. While not exactly Microsoft money, Red Hat, the largest purely open source software firm, reported half a billion dollars in revenue in 2008. The firm had 2.5 million *paid* subscriptions offering access to software updates and support services[25]. Oracle, a firm that sells commercial ERP and database products, provides Linux for free, selling high-margin Linux

[23] Asay, 2008a
[24] Greenberg 2008
[25] Greenberg 2008

support contracts for as much as $500,000[26]. The added benefit for Oracle? Weaning customers away from Microsoft – a firm that sells many products that compete head-to-head with Oracle's offerings. Service also represents the most important part of IBM's business. The firm now makes more from services than from selling hardware and software[27]. And every dollar saved on buying someone else's software product means more money IBM customers can spend on IBM computers and services. Sun uses open source to drive advanced hardware sales, but the firm also sells proprietary products that augment its opens source efforts. These include special optimization, configuration management, and performance tools that can tweak open source code to work its best[28].

Here's where we also can relate the industry's evolution to what we've learned about standards competition in our earlier chapter. In the pre-Linux days, nearly every major hardware manufacturer made its own, incompatible version of the Unix operating system. This bunch of fractured, incompatible markets were each so small that they had difficulty attracting third-party vendors to write application software. Now, much to Microsoft's dismay, all major hardware firms run Linux. That means there's a large, unified market that attracts software developers who might otherwise write for Windows.

To keep standards unified, several Linux-supporting hardware and software firms also back Open Source Development Labs located in Beaverton, Oregon. The nonprofit effort employs Linus Torvalds himself to oversee Linux's evolution. Sharing development expenses in open source software has been likened to going in on a pizza together. Everyone wants a pizza with the same ingredients. The pizza doesn't make you smarter or better. So why not share the cost of a bigger pie instead of buying by the slice[29]? With OSS, hardware firms spend less money than they would in the brutal, head-to-head competition where each once offered a me-too operating systems that was incompatible with rivals, but offered little differentiation. Hardware firms now find their technical talent can be deployed in other value-added services mentioned above: developing commercial software add-ons, offering consulting services, and enhancing hardware offerings.

Linux on the Desktop?

While Linux is a major player in enterprise software, mobile phones, and consumer electronics, the Linux OS can only be found on a tiny fraction of desktop computers. There are several reasons for this. Some suggest Linux simply isn't as easy to install and use as Windows or the Mac OS. This complexity can raise the *total cost of ownership* (*TCO*) of Linux desktops, with additional end-user support offsetting any gains from free software. The small number of desktop users also dissuades third party firms from porting popular desktop applications over to Linux. For consumers in most industrialized nations, the added complexity and limited desktop application availability of desktop Linux just it isn't worth the one to two hundred dollars saved by giving up Windows.

But in developing nations where incomes are lower, the cost of Windows can be daunting. Consider the OLPC, Nicholas Negroponte's "$100" laptop. An additional $100 for Windows would double the

[26] Fortt 2007
[27] Robertson, 2009
[28] Preimesberger, 2008
[29] Cohen 2008

cost for the non-profit's machines. It's not surprising that the first OLPC laptops ran Linux. Microsoft recognizes that if a whole generation of first-time computer users grows up without Windows, they may favor open-source alternatives years later when starting their own businesses. As a result, Microsoft has begun offering low-cost versions of Windows (in some cases for as little as $7) in nations where populations have much lower incomes. Microsoft has even offered a version of Windows to the backers of the OLPC. While Microsoft won't make much money on these efforts, the low cost versions will serve to entrench Microsoft products as standards in emerging markets, staving off open source rivals; positioning the firm to raise prices years later when income levels rise.

MySQL: "Turning a $10 billion-a-year business into a $1 billion one"

Finland isn't the only Scandinavian country to spawn an open-source powerhouse. Uppsala Sweden's MySQL (pronounced 'my sequel') is the "M" in the LAMP stack, and is used by organizations as diverse as FedEx, Lufthansa, NASA, Sony, UPS, and YouTube.

The *SQL* in name stands for the *structured query language*, a standard method for organizing and accessing data. SQL is also employed by commercial database products from Oracle, Microsoft, and Sybase. Even Linux-loving IBM uses SQL in its own, lucrative DB2 commercial database product. Since all of these databases are based on the same standard, switching costs are lower, so migrating from a commercial product to MySQL's open source alternative is relatively easy. And that spells trouble for commercial firms. Granted, the commercial efforts offer some bells and whistles that MySQL doesn't yet have, but those extras aren't necessary in a lot of standard database use. Some organizations, impressed with MySQL's capabilities, are mandating its use on all new development efforts, attempting to cordon off proprietary products in legacy code that is maintained but not expanded.

Savings from using MySQL can be huge. The website PriceGrabber pays less than $10,000 in support for MySQL vs. $100,000 to $200,000 for a comparable Oracle effort. Lycos Europe switched from Oracle to MySQL and slashed costs from $120,000 a year to $7,000. And the travel reservation firm Sabre used open source products such as MySQL to slash ticket purchase processing costs by 80 percent[30].

MySQL does make money, just not as much as its commercial rivals. While you can download a version of MySQL over the net, the firm also sells its flagship product for $495 per server computer vs. a list price for Oracle that can climb as high as $160,000. Of the roughly 11 million copies of MySQL in use, the company only gets paid for about 1 in 1,000[31]. Firms pay for what's free for one of two reasons: 1) for MySQL service, and 2) for the right to incorporate MySQL's code into their own products[32]. Amazon, Facebook, Gap, NBC, and Sabre pay MySQL for support; Cisco, Ericsson, HP, and Symantec pay for the rights to the code[33]. Top-level round-the-clock support for MySQL for up to 50 servers is $50,000 a year, still a fraction of the cost for commercial alternatives. Founder Marten Mickos has stated an explicit goal of the firm is "turning the $10 billion-a-year database business into a $1 billion one"[34].

[30] Lyons, 2004
[31] Ricadela, 2007
[32] Kirkpatrick, 2004
[33] Ricadela, 2007
[34] Kirkpatrick, 2004

When Sun Microsystems spent over $1 billion to buy Mickos' MySQL in 2008, Sun CEO Jonathan Schwartz called the purchase the 'most important acquisition in the company's history'[35]. But it's a complicated purchase. While Sun hopes the cheap database software can make the firm's hardware offerings seem more attractive, Sun also has a lucrative business selling hardware to support commercial ERP and database software from Oracle. Will hyper-competitive Oracle CEO Larry Ellison continue to promote Sun hardware for Oracle customers, or is the firm now incented to favor Sun's rivals? Such is the nature of Silicon Valley competition. Some use the term co-opetition to describe a business environment where firms are simultaneously partners and rivals. A FastCompany article referred to the phenomenon as the 'frenemies' problem, where friends are enemies. MySQL's revenues have grown 55 percent just one year after the acquisition[36], but time will tell if the firm that controls about three quarters of the web database market was really worth a billion.

Legal Risks and Open Source Software: A Hidden and Complex Challenge

Open Source Software isn't without its risks. Competing reports cite certain open source products as being difficult to install and maintain (suggesting potentially higher total cost of ownership, or TCO). Adopters of OSS without support contracts may lament having to rely on an uncertain community of volunteers to support their problems and provide innovative upgrades. Another major concern is legal exposure. Firms adopting open source software may be at risk if they distribute code and aren't aware of the licensing implications. Some commercial software firms have pressed legal action against the users of open source products when there is a perceived violation of software patents or other unauthorized use of their proprietary code.

For example, in 2007 Microsoft suggested that Linux and other open-source software efforts violated some 235 of its patents[37]. The firm began collecting payments and gaining access to the patent portfolios of companies that use the open-source Linux operating system in their products, including Fuji, Samsung, and Xerox. Microsoft also cut a deal with Linux vendor Novell in which both firms pledged not to sue each other's customers for potential patent infringements.

Also complicating issues are the varying open source license agreements (these go by various names, such as GPL and the Apache License), each with slightly different legal provisions – many of which have evolved over time. Keeping legal with so many licensing standards can be a challenge, especially for firms that want to bundle open source code into their own products[38]. An entire industry has sprouted up to help firms navigate the minefield of open source legal licenses. Chief among these are products, such as those offered by the firm Black Duck, which analyze the composition of software source code and report on any areas of concern so that firms can honor any legal obligations associated with their offerings. Keeping legal requires effort and attention, even in an environment where products are allegedly 'free'. This also shows that even corporate lawyers had best geek-up if they want to prove they're capable of navigating a 21st century legal environment.

KEY TAKEAWAYS

- Business models for firms in the open source industry are varied, and can include selling services, licensing OSS for incorporation into commercial products, and using OSS to fuel hardware sales.
- Many firms are trying to use OSS markets to drive a wedge between commercial competitors and their customers.

[35] Shankland, 2008
[36] Asay, 2009
[37] Ricadela, 2007
[38] Lacy, 2006

- Linux has been very successful on mobile devices and consumer electronics, as well as on high-end server class and above computers. But it has not been as successful on the desktop. The small user base for desktop Linux makes the platform less attractive for desktop software developers.
- MySQL is the dominant open source database software product. Adoption of the SQL standard eases some issues with migrating from commercial products to MySQL. Sun's purchase of MySQL raises the challenge of co-opetition, where firms both cooperate and compete with rivals.
- Open source software also has several drawbacks and challenges that limit its appeal. These include complexity of some products and a higher total cost of ownership, and concern about the ability of a product's development community to provide support or product improvement.
- Also concerning are legal issues: these include uncertainty regarding the origin and potential patent and copyright violations in some OSS code, and the complexity over the varying commercial licenses that govern what a firm can and can't do with OSS.

CLOUD COMPUTING: HYPE OR HOPE?

Oracle Chairman Larry Ellison, lamenting the buzzword-chasing character of the tech sector, once complained that the computer industry is more fashion-focused than even the women's clothing business[39]. Ellison has a point: when a technology term becomes fashionable, the industry hype machine shifts into overdrive. The technology attracts press attention, customer interest, and vendor marketing teams scramble to label their products and services as part of that innovation. Recently, few tech trends have been more fashionable than *cloud computing*.

Like Web 2.0, trying to nail down an exact definition for cloud computing is tough. In fact, it's been quite a spectacle watching industry execs struggle to clarify the concept. HP's Chief Strategy Office "politely refused" when asked by *BusinessWeek* to define the term cloud computing[40]. Richard Stallman, founder of the Free Software Foundation said about cloud computing "It's worse than stupidity. It's a marketing hype campaign"[41]. And Larry Ellison, always ready with a sound bite, offered up this priceless quip: "Maybe I'm an idiot, but I have no idea what anyone is talking about. What is it? It's complete gibberish. It's insane"[42]. Insane, maybe, but also big bucks. By year-end 2008, the various businesses that fall under the rubric of cloud computing had already accounted for an estimated $36 billion market. That represents a whopping 13 percent of global software sales[43]!

As we examine what's really going on 'in the cloud', we'll rely on a definition from *BusinessWeek*, referring to cloud computing as "any situation in which computing is done in a remote location (out in the clouds), rather than on your desktop or portable computing device"[44].

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[39] Kerstetter, 2002
[40] Hamm, 2008
[41] McKay, 2009
[42] Lyons, 2008
[43] Liedtke, 2008
[44] Hamm, 2008

The name actually comes from the popular industry convention of drawing the Internet or other computer network as a big cloud.

Cloud computing encompasses a bunch of different efforts. We'll concentrate on describing, providing examples, and analyzing the managerial implications of two separate categories of cloud computing: 1) *Software as a Service* (*SaaS*), where a firm subscribes to a third-party software-replacing service that is delivered online; and 2) models often referred to as *utility computing*, *platform as a service*, or *infrastructure as a service*. Using these latter techniques, an organization develops its own systems, but runs them over the Internet on someone else's hardware.

The benefits and risks of SaaS and the utility computing-style efforts are very similar, but understanding the nuances of each effort can help you figure out if and when the cloud makes sense for your organization. The evolution of cloud computing also has huge implications across the industry: from the financial future of hardware and software firms, to cost structure and innovativeness of adopting organizations, to the skill sets likely to be most valued by employers.

KEY TAKEAWAYS

- Cloud computing is difficult to define.. Managers and techies use the term cloud computing to describe services provided over a network, most often commercial services provided over the Internet by a third party.
- Software as a Service (SaaS) refers to a third-party software-replacing service that is delivered online.
- Hardware cloud computing replaces hardware that a firm might otherwise purchase.
- Estimated to be a $36 billion industry, cloud computing is reshaping software, hardware, and service markets, and is impacting competitive dynamics across industries.

THE SOFTWARE CLOUD: WHY BUY WHEN YOU CAN RENT?

If open source isn't enough of a threat to firms that sell packaged software, a new generation of products, collectively known as SaaS, claims that you can now get the bulk of your computing done through your web browser. Don't install software – let someone else run it for you and deliver the results over the Internet.

Software as a Service (*SaaS*) refers to software that is made available by a third party online. You might also see the terms ASP (application service provider) or HSV (hosted software vendor) used to identify this type of offering. SaaS is potentially a very big deal. Firms using SaaS products can dramatically lower several costs associated with the care and feeding of their information systems, including software licenses, server hardware, system maintenance, and IT staff. Most SaaS firms earn money via a usage-based pricing model akin to a monthly subscription. Others offer free services that are supported by advertising, while others promote the sale of upgraded or premium versions for additional fees.

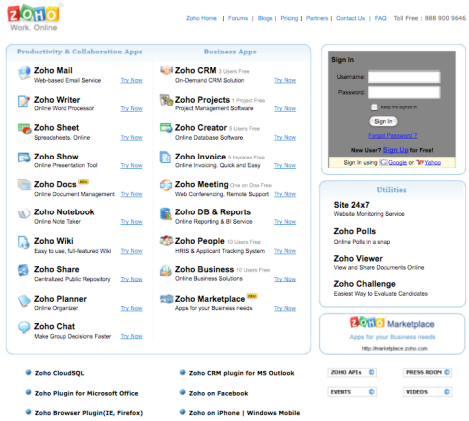
Make no mistake, SaaS is yet another direct assault on traditional software firms. The most iconic SaaS firm is Salesforce.com, an enterprise customer relationship management (CRM)

provider. This un-software company even sports a logo featuring the word 'software' crossed out, *Ghostbusters*-style[45].

The anti-software message is evident in the logo of SaaS leader Salesforce.com

Other enterprise-focused SaaS firms compete directly with the biggest names in software. Some of these upstarts are even backed by leading enterprise software executives. Examples include NetSuite (funded in part by Oracle's Larry Ellison – the guy's all over this chapter), which offers a comprehensive SaaS ERP suite, and Workday (launched by founders of Peoplesoft) which has SaaS offerings for managing human resources. Several traditional software firms have countered startups by offering SaaS efforts of their own. IBM offers a SaaS version of its Cognos business intelligence products, Oracle offers CRM On Demand, and SAP's Business ByDesign includes a full suite of enterprise SaaS offerings. Even Microsoft has gone SaaS, with a variety of web-based services that include CRM, web meeting tools, collaboration, e-mail, and calendaring.

SaaS is also taking on desktop applications. Intuit has online versions of its QuickBooks, TurboTax, and Quicken finance software. Adobe has an online version of Photoshop. Google and Zoho offer office suites that compete with desktop alternatives. And if you store photos on Flickr or Picassa instead of your PC's hard drive, then you're using SaaS, too.



A look at Zoho's home page shows the diversity of both desktop and enterprise offerings from this SaaS upstart. Note that the firm makes it services available through browsers, phones, and even on Facebook

The Benefits of SaaS

Firms can potentially save big using SaaS. Organizations that adopt SaaS forgo the large upfront costs of buying installed software packages. For large enterprises, the cost to license, install, and configure products like ERP and CRM systems can easily run into the hundreds of thousands, or even millions of dollars. And these costs are rarely a one-time fee. Additional costs like annual maintenance contracts have also been rising as rivals fail or get bought up. Less competition

[45] Hempel, 2009

among traditional firms recently allowed Oracle and SAP to raise maintenance fees to as much as 20 percent[46].

Firms that adopt SaaS don't just save on software and hardware, either. There's also the added cost for the IT staff needed to run these systems. Forrester Research estimates that SaaS can bring cost savings of 25 to 60 percent if all these costs are factored in[47].

There are also accounting and corporate finance implications for SaaS. Firms that adopt software as a service never actually buy a system's software and hardware so these systems become a variable operating expense. This flexibility helps mitigate the financial risks associated with making a large capital investment in information systems. For example, if a firm pays Salesforce.com $65/month per user for its CRM software, it can reduce payments during a slow season with a smaller staff, or pay more during heavy months when a firm might employ temporary workers. At these rates, SaaS not only looks good to large firms, it makes very sophisticated technology available to smaller firms that otherwise wouldn't be able to afford expensive systems, let alone the IT staff and hardware required to run them.

In addition to cost benefits, SaaS systems also offer the advantage of being highly scalable. This is important because many organizations operate in environments prone to wide variance in usage. Some firms might expect systems to be particularly busy during tax time or the period around quarterly financial reporting deadlines, while others might have their heaviest system loads around a holiday season. A music label might see spikes when an artist drops a new album. Using conventional software, an organization would have to buy enough computing capacity to ensure that it could handle its heaviest anticipated workload. But sometimes these loads are difficult to predict, and if the difference between high workloads and average use is great, a lot of that expensive computer hardware will spend most of its time doing nothing. In SaaS, however, the vendor is responsible for ensuring that systems meet demand fluctuation. Vendors frequently sign *service level agreements* with their customers to ensure a guaranteed uptime and define their ability to meet demand spikes.

When looking at the benefits of SaaS, also consider the potential for higher quality and service levels. SaaS firms benefit from economies of scale that not only lower software and hardware costs, they also potentially boost quality. The volume of customers and diversity of their experiences means that an established SaaS vendor is an expert in dealing with all sorts of critical computing issues. SaaS firms handle backups, instantly deploy upgrades and bug fixes, and deal with the continual burden of security maintenance – all costly tasks that must be performed regularly and with care, although each offers little strategic value to an individual firm. The breadth of a SaaS vendor's customer base typically pushes the firm to evaluate and address new technologies as they emerge, like quickly offering accessibility from mobile platforms like the Blackberry and iPhone. For all but the savviest of IT shops, an established SaaS vendor can leverage its scale and experience to provide better, cheaper, more reliable standard information systems than individual companies typically can.

[46] Lacy, 2008
[47] Quittner, 2008

Software developers who choose to operate as SaaS providers also realize benefits. While a packaged software company like SAP must support multiple versions of its software to accommodate operating systems like Windows, Linux, and various flavors of Unix, a SaaS provider develops, tests, deploys, and supports just one version.

An argument might also be made that SaaS vendors are more attuned to customer needs. Since SaaS firms run a customer's systems on their own hardware, they have a tighter feedback loop in understanding how products are used (and why they fail) – potentially accelerating their ability to enhance their offerings. And once made, enhancements or fixes are immediately available to customers the next time they log in.

SaaS applications also impact distribution costs and capacity. As much as 30 percent of the price of traditional desktop software is tied to the cost of distribution - pressing CD-ROMs, packaging them in boxes, and shipping them to retail outlets[48]. Going direct to consumers can cut out the middleman, so vendors can charge less or capture profits that they might otherwise share with a store or other distributor. Going direct also means that SaaS applications are available anywhere someone has an Internet connection, making them truly global applications. This has allowed many SaaS firms to address highly specialized markets (sometimes called *vertical niches*). For example, the Internet allows a company writing, say specialized legal software, or a custom package for the pharmaceutical industry, to have a national deployment footprint from day 1. Vendors of desktop applications that go SaaS benefit from this kind of distribution, too.

Finally, SaaS allows a vendor to counter the vexing and costly problem of software piracy. It's just about impossible to make an illegal copy of a subscription service

KEY TAKEAWAYS:
SaaS firms may offer their clients several benefits including:
- *lower costs* by eliminating or reducing software, hardware, maintenance, and staff expenses.
- *financial risk mitigation* since startup costs are so low.
- potentially *faster deployment times* compared with installed packaged software or systems developed in-house.
- costs are a *variable operating expense* rather than a large, fixed capital expense.
- *scalable systems* make it easier for firms to endure periods of high system use.
- *higher quality and service levels* through instantly available upgrades, vendor scale economies, and expertise gained across its entire client base.
- *remote access and availability* – most SaaS offerings are accessed through any web browser, and often even by phone or other mobile device.

Vendors of SaaS products benefit by:
- *limiting development to a single platform*, instead of having to create versions for different operating systems.
- *tighter feedback loop* with clients, helping fuel innovation and responsiveness.
- ability to *instantly deploy bug fixes and product enhancements* to all users.
- *lower distribution costs*.

[48] Drummond, 2001

- *accessibility* to anyone with an Internet connection.
- greatly *reduces software piracy*.

SaaS: Not Without Risks

Like any technology, we also recognize there is rarely a silver bullet that solves all problems. A successful manager is able to weigh the benefits of a technology against its weaknesses and limitations, and there are still several major concerns surrounding SaaS.

The largest concerns involve the tremendous dependence a firm develops with its SaaS vendor. Having all of your eggs in one basket can leave a firm particularly vulnerable. If a traditional software company goes out of business, in most cases its customers can still go on using its products. But if your SaaS vendor goes under, you're hosed. They've got all of your data, and even if firms could get their data out, most organizations don't have the hardware, staff, or expertise to quickly absorb an abandoned function.

Beware who you partner with. Any hot technology is likely to attract a lot of startups, and most of these startups are unlikely to survive. In just a single year, the leading trade association found the number of SaaS vendors dropped from 700 members to 450[49]. One of the early efforts to collapse was Pandesic, a joint venture between SAP and Intel – two large firms that might have otherwise instilled confidence among prospective customers. In another example, Danish SaaS firm "IT Factory" was declared "Denmark's Best IT Company 2008" by *Computerworld*, only to follow the award one week later with a bankruptcy declaration[50]. Indeed, despite the benefits, the costs of operating as a SaaS vendor can be daunting. NetSuite's founder claimed it "takes 10 years and $100 million to do right"– maybe that's why the firm still wasn't profitable, even a year after going public[51].

Firms that buy and install packaged software usually have the option of sticking with the old stuff as long as it works, but organizations adopting SaaS may find they are forced into adopting new versions. This is important because any radical changes in a SaaS system's user interface or system functionality might result in unforeseen training costs, or increase the chance that a user might make an error.

Keep in mind that SaaS systems are also reliant on a network connection. If a firm's link to the Internet goes down, its link to its SaaS vendor is also severed. Relying on an Internet connection also means that data is transferred to and from a SaaS firm at Internet speeds, rather the potentially higher speeds of a firm's internal network. Solutions to many of these issues are evolving as Internet speeds become faster and internet service providers become more reliable. There are also several programs that allow for off-line use of data that typically stored in SaaS systems, including Google Gears and Adobe AIR. With these products a user can download a subset of data to be offline (say on a plane flight or other inaccessible location), and then sync

[49] Drummond, 2001
[50] Wauters, 2008
[51] Lacy, 2008

the data when the connection is restored. Ultimately, though, SaaS users have a much higher level of dependence on their Internet connections.

And although a SaaS firm may have more security expertise than your organization, that doesn't mean that security issues can be ignored. Any time a firm allows employees to access a corporation's systems and data assets from a remote location, a firm is potentially vulnerable to abuse and infiltration. Some firms may simply be unacceptably uncomfortable with critical data assets existing outside their own network. There may also be contractual or legal issues preventing data from being housed remotely, especially if a SaaS vendor's systems are in another country operating under a different laws and regulations. "We're very bound by regulators in terms of client data and country-of-origin issues, so it's very difficult to use the cloud," says Rupert Brown, a chief architect at Merrill Lynch[52].

SaaS systems are often accused of being less flexible than their installed software counterparts – mostly due to the more robust configuration and programming options available in traditional software packages. It is true that many SaaS vendors have improved system customization options and integration with standard software packages. And at times a lack of complexity can be a blessing – fewer choices can mean less training, faster startup time, and lower costs associated with system use. But firms with unique needs may find SaaS restrictive.

SaaS offerings usually work well when the bulk of computing happens at the server end of a distributed system. This is because the kind of user interface you can create in a browser isn't as sophisticated as what you can do with a separate, custom-developed desktop program. A comparison of the first few iterations of the web-based Google office suite, which offers word processing, presentation software, and a spreadsheet, reveals a much more limited feature set than Microsoft's Office desktop software. The bonus, of course, is that an online office suite is accessible anywhere and makes sharing documents a snap. Again, an understanding of tradeoffs is key.

Here's another challenge for a firm and its IT staff: SaaS means a greater *consumerization* of technology. Employees, at their own initiative, can go to SocialText or Google Sites and set up a wiki, WordPress to start blogging, or subscribe to a SaaS offering like SalesForce.com, all without corporate oversight and approval. This work can result in employees operating outside established firm guidelines and procedures; potentially introducing operational inconsistencies or even legal and security concerns.

The consumerization of corporate technology isn't all bad. Employee creativity can blossom with increased access to new technologies, costs might be lower than home-grown solutions, and staff could introduce the firm to new tools that might not otherwise be on the radar of the firm's IS Department. But all this creates an environment that requires a level of engagement between a firm's technical staff and the groups that it serves that is deeper than that employed by any prior generation of technology workers. Those working in an organization's information systems group must be sure to conduct regular meetings with representative groups of employees across the firm to understand their pain points and assess their changing technology needs. Non-IT

[52] Gruman, 2008

managers should regularly reach out to IT to ensure that their needs are on the tech staff's agenda. Organizations with internal R&D functions that scan new technologies and critically examine their relevance and potential impact on the firm can help guide an organization through the promise and peril of new technologies. Now more than ever, IT managers must be deeply knowledgeable about business areas, broadly aware of new technologies, and able to bridge the tech and business worlds. Similarly, any manager looking to advance his or her organization has to regularly consider the impact of new technologies.

KEY TAKEAWAYS:
The risks associated with SaaS include:
- *dependence on a single vendor*.
- concern about the long-term *viability of partner firms*.
- users *may be forced to migrate to new versions* – possibly incurring unforeseen training costs and shifts in operating procedures.
- *reliance on a network connection* – which may be slower, less stable, and less secure.
- *data asset stored off-site* – with the potential for security and legal concerns.
- *limited configuration, customization, and system integration options* compared to packaged software or alternatives developed in-house.
- *software is often less sophisticated and lacks the richness of most desktop alternatives*.
- ease of adoption *may lead to pockets of unauthorized IT* being used throughout an organization.

Gaming in Flux: is there a future in free?

PC game makers are in a particularly tough spot. Development costs are growing as games become more sophisticated. But profits are plummeting as firms face rampant piracy, a growing market for used game sales, and lower sales from rental options from firms like Blockbuster and GameFly. To combat these trends, Electronic Arts (EA) has begun to experiment with a radical alternative to PC game sales – give the base version of the product away for free and make money by selling additional features.

The firm started with the Korean version of its popular FIFA soccer game. Koreans are crazy for the world's most popular sport; their nation even co-hosted the World Cup in 2002. But piracy was killing EA's sales in Korea. To combat the problem, EA created a free, online version of FIFA that let fans pay for additional features and upgrades, such as new uniforms for their virtual teams, or performance-enhancing add-ons. Each enhancement only costs about $1.50, but the move to a model based on these so-called '*micro-transactions*' has brought in big earnings. During the first two years that the micro-transaction-based Korean FIFA game was available, EA raked in roughly $1 million a month. The 2-year, $24 million take was twice the sales record for EA's original FIFA game.

Asian markets have been particularly receptive to micro-transactions – they make up a whopping 50 percent of the region's gaming revenues. Whether this model can spread to other parts of the world remains to be seen. The firm's first micro-transaction outside of Korea leverages EA's popular *Battlefield* franchise. *Battlefield Heroes* sports lower-quality, more cartoon-like graphics than EA's conventional *Battlefield* offerings, but it will be offered free online. Lest someone think they can rise to the top of player rankings by buying the best military hardware for their virtual armies, EA offers a sophisticated matching engine, pitting players with similar abilities and add-ons against one another[53].

[53] Schenker, 2008

Players of the first versions of *Battlefield Heroes* and *FIFA Online* needed to download software to their PC. But the startup *World Golf Tour* shows how increasingly sophisticated games can execute within a browser, SaaS-style. WGT doesn't have quite the graphics sophistication of the dominant desktop golf game (EA's Tiger Woods PGA Golf), but the free, ad-supported offering is surprisingly detailed. Buddies can meet up online for a virtual foursome, played on high-resolution representations of the world's elite courses stitched together from fly-over photographs taken as part of game development. World Golf Tour is ad-supported. The firm hopes that advertisers will covet access to the high-income office workers likely to favor a quick virtual golf game to break up their workday. *FIFA Online*, *Battlefield Heroes*, and *World Golf Tour* all show that the conventional models of gaming software are just as much in flux as this facing business and productivity packages.

THE HARDWARE CLOUD: UTILITY COMPUTING & ITS COUSINS

While SaaS provides the software *and* hardware to replace an internal information system, sometimes a firm develops its own custom software but wants to pay someone else to run it for them. That's where *utility computing* and related technologies come in. With utility computing, a firm replaces computing hardware that it might otherwise run on-site with a service provided by a third party online. While the term utility computing was fashionable a few years back (and old-timers claim it shares a lineage with terms like hosted computing or even time-sharing), now most in the industry have begun referring to this as an aspect of cloud computing. Computing hardware used in this scenario exists in the cloud, meaning somewhere on the internet. The costs of systems operated in this manner look more like a utility bill – you only pay for the amount of processing, storage, and telecommunications used. Tech research firm Gartner has estimated that 80 percent of corporate tech spending goes toward data center maintenance[54]. Hardware-focused cloud computing provides a way for firms to chip away at these costs.

Major players are spending billions building out huge data centers to take all kinds of computing out of the corporate data center and place it 'in the cloud'. Efforts include Sun's Network.com grid, IBM's Cloud Labs, Amazon's EC2 (Elastic Computing Cloud), Google's App Engine, Microsoft's Azure, and Salesforce.com's Force.com. While cloud vendors typically host your software on their systems, many of these vendors also offer additional tools to help in creating and hosting apps in the cloud. Salesforce.com offers Force.com which includes not only a hardware cloud, but also several cloud-supporting tools, including a programming environment (IDE) to write applications specifically tailored for web-based delivery. Google's App Engine offers developers a database product called Big Table, while Amazon's offers one called Amazon DB. Traditional software firms like Oracle are also making their products available to developers through various cloud initiatives.

Still other cloud computing efforts focus on providing a virtual replacement for operational hardware like storage and backup solutions. These include the cloud-based backup efforts like EMC's Mozy, and corporate storage services like Amazon's Simple Storage Solution (S3). Even efforts like Apple's MobileMe and Microsoft's Live Mesh that sync user data across devices (phone, multiple desktops) are considered part of the cloud craze. The common theme in all of this is leveraging the Internet to satisfy the computing needs of both users and organizations.

[54] Rayport, 2008

Clouds in Action: A Snapshot of Diverse Efforts

Large, established organizations, small firms and startups are all embracing the cloud. The examples below illustrate the wide range of these efforts.

Journalists refer to *The New York Times* as, "The Old Gray Lady", but it turns out that the venerable paper is a cloud-pioneering whippersnapper. When the *Times* decided to make roughly 150 years of newspaper archives (over 15 million articles) available over the Internet, it realized that the process of converting scans into searchable .pdfs would require more computing power than the firm had available[55]. To solve the challenge, a *Times* IT staffer simply broke out a credit card and signed up for Amazon's EC2 cloud computing and S3 cloud storage services. The *Times* then started uploading terabytes of information to Amazon, along with a chunk of code to execute the conversion. While anyone can sign up for services online without speaking to an rep, someone from Amazon eventually contacted the *Times* to check in after noticing the massive volume of data coming into its systems. Using one hundred of Amazon's Linux servers, the *Times* job took just 24 hours to complete. In fact, a coding error in the initial batch forced the paper to re-run the job. Even the blunder was cheap – just $240 in extra processing costs. Says a member of the *Times* IT group: "It would have taken a month at our facilities, since we only had a few spare PCs… It was cheap experimentation, and the learning curve isn't steep."[56]

Nasdaq also uses Amazon's cloud as part of its Market Replay system. The exchange uses Amazon to make terabytes of data available on-demand, and uploads an additional 30 to 80 gigabytes every day. Market Reply allows access through an Adobe AIR interface to pull together historical market conditions in the 10 minute period surrounding a trade's execution. This allows Nasdaq to produce a snapshot of information for regulators or customers who question a trade. Says the exchange's VP of Product Development: "The fact that we're able to keep so much data online indefinitely means the brokers can quickly answer a question without having to pull data out of old tapes and CD backups."[57] Nasdaq isn't the only major financial organization leveraging someone else's cloud. Others include Merrill Lynch, which uses IBM's Blue Cloud servers to build and evaluate risk analysis programs; and Morgan Stanley, which relies on Force.com for recruiting applications.

Sun's Network.com offering is essentially a grid computer in the clouds (see chapter *Moore's Law and Moore*). Since grid computers break a task up to spread across multiple processors, the Sun service is best for problems that can be easily divided into smaller mini-jobs that can be processed simultaneously by the army of processors in Sun's grid. The firm's cloud is particularly useful for performing large-scale image and data tasks. Infosolve, a data management firm, uses the Sun cloud to scrub massive data sets, at times harnessing thousands of processors to comb through client records and correct inconsistent entries.

IBM Cloud Labs, which counts Elizabeth Arden and the U.S. Golf Association among its customers, offers several services, including so-called *cloudbursting*. In a cloudbursting scenario a firm's data center running at maximum capacity can seamlessly shift part of the workload to IBM's cloud, with any spikes in system use metered, utility-style. Cloudbursting is appealing because forecasting demand is difficult and can't account for the ultra-rare high-impact events, sometimes called black swans. Planning to account for usage spikes explains why the servers at many conventional corporate IS shops run at only 10-20 percent capacity[58]. While Cloud Labs *cloudbursting* service is particularly appealing for firms that already have a heavy reliance on IBM hardware in house, it is possible to build these systems using the hardware clouds of other vendors, too.

[55] Rayport, 2008
[56] Gruman, 2008
[57] Grossman, 2009
[58] Parkinson,

Salesforce.com's Force.com cloud is especially tuned to help firms create and deploy custom web applications. The firm makes it possible to piece together projects using pre-made web services that provide software building blocks for features like calendaring and scheduling. The integration with the firm's SaaS CRM effort, and with third-party products like Google Maps allows enterprise mash-ups that can combine services from different vendors into a single application that's run on Force.com hardware. The platform even includes tools to help deploy Facebook applications. Intuitive Surgical used Force.com to create and host a custom application to gather clinical trial data for the firm's surgical robots. An IS manager at Intuitive noted, "We could build it using just their tools, so in essence, there was no programming."[59] Other users include Jobscience, which used Force.com to launch its online recruiting site; and Harrah's Entertainment, which uses Force.com applications to manage room reservations, air travel programs, and player relations.

These efforts compete with a host of other initiatives, including Google's App Engine and Microsoft's Azure Services Platform, as well as cloud-specific upstarts like GoGrid and Mosso.

Challenges Remain

Hardware clouds and SaaS share similar benefits and risk, and as our discussion of SaaS showed, cloud efforts aren't for everyone. Some additional examples illustrate the challenges in shifting computing hardware to the cloud.

For all the hype about cloud computing, it doesn't work in all situations. From an architectural standpoint, most large organizations run a hodgepodge of systems that include both package applications and custom code written in-house. Installing a complex set of systems on someone else's hardware is just about impossible. For that reason we can expect most cloud computing efforts to focus on new software development projects rather than options for old software. Even for efforts that can be custom built and cloud deployed, other roadblocks remain. For example, some firms face stringent regulatory compliance issues. To quote one tech industry executive: "How do you demonstrate what you are doing is in compliance when it is done outside?"[60]

Firms considering cloud computing need to do a thorough financial analysis, comparing the capital and other costs of owning and operating their own systems over time against the variable costs over the same period for moving portions to the cloud. For high-volume, low-maintenance systems, the numbers may show that it makes sense to buy rather than rent. Cloud costs can seem super-cheap at first. Sun's early cloud effort offered a flat fee of $1 per CPU per hour. Amazon's cloud storage rates were 25 cents per gig per month. But users often also pay for the number of accesses and the number of data transfers[61]. A quarter a gig a month may seem like a small amount, but system maintenance costs often include the need to clean up old files or put them on tape. If unlimited data is stored in the cloud, these costs can add up.

Firms should enter the cloud cautiously, particularly where mission-critical systems are concerned. When one of the three centers supporting Amazon's cloud briefly went dark in 2008, startups relying on the service, including Twitter and SmugMug, reported outages. Apple's

[59] Gruman, 2008
[60] Gruman, 2008
[61] Preimesberger, 2008

MobileMe cloud-based product for synchronizing data across computers and mobile devices, struggled for months after its introduction when the cloud repeatedly went down. Vendors with multiple data centers that are able to operate with fault-tolerant provisioning, keeping a firm's efforts at more than one location to account for any operating interruptions, will appeal to firms with stricter uptime requirements.

KEY TAKEAWAYS

- It's estimated that 80 percent of corporate tech spending goes toward data center maintenance. Hardware-focused cloud computing initiatives from third party firms help tackle this cost by allowing firms to run their own software on the hardware of the provider.
- Sun, IBM, Amazon, Google, Microsoft and Salesforce.com are all offering platforms to run custom software projects. Some offer additional tools and services, including additional support for cloud-based software development, hosting, application integration, and backup.
- Users of cloud computing run the gamut of industries, including publishing (the *NY Times*), finance (Nasdaq), and cosmetics and skin care (Elizabeth Arden).
- Benefits and risks are similar to those discussed in SaaS efforts. Benefits include the use of the cloud for handling large batch jobs, offloading expensive computing tasks, and cloudbursting efforts that handle system overflow when an organization needs more capacity.
- Most legacy systems can't be easily migrated to the cloud, meaning most efforts will be new efforts or those launched by younger firms.
- Some firms may still find the economics favor buying over renting – scale sometimes suggests an organization is better off keeping efforts in house.

CLOUDS & TECH INDUSTRY IMPACT

Although still a relatively recent phenomenon, cloud computing's impact across industries is already proving to be broad and significant.

Cloud computing is affecting the competitive dynamics of the hardware, software, and consulting industries. In the past, firms seeking to increase computing capacity invested heavily in expensive, high margin server hardware, creating a huge market for computer manufacturers. But now hardware firms find these markets may be threatened by the cloud. The trend shifting from hardware to services is evident in IBM's quarterly numbers. The firm recently reported its overall earnings were up 12 percent, even though hardware sales were off by 20 percent[62]. What made up the difference? The growth of Big Blue's services business. IBM is particularly well positioned to take advantage of the shift to services because it employs more technology consultants than any other firm in the world, while most of its competitors are forced to partner to offer something comparable. Consulting firm Capgemini's partnership to offer cloud services through Amazon is one such example.

The shift to cloud computing also alters the margin structure for many in the computing industry. While Moore's Law has made servers cheap, deploying SaaS and operating a commercial cloud is still very expensive – much more so than simply making additional copies of conventional, packaged software. Microsoft surprised Wall Street when it announced it would need to pour at

[62] Fortt, 2009

least $2 billion more than analysts expected into the year's server farm capital spending. The firm's stock – among the world's most widely held - sank 11 percent in a day[63]. As a result, many portfolio managers started playing closer attention to the business implications of the cloud.

Cloud computing can accelerate innovation and therefore changes the desired skills mix and job outlook for IS workers. If cloud computing customers spend less on expensive infrastructure investments, they potentially have more money to reinvest in strategic efforts and innovation. IT careers may change, too. Demand for non-strategic skills like hardware operations and maintenance are likely to decrease. Organizations will need more business-focused technologists who intimately understand a firm's competitive environment, and can create systems that add value and differentiate the firm from its competition[64]. While these tech jobs require more business training, they're also likely to be more durable and less likely to be outsourced to a third party with a limited understanding of the firm.

By lowering the cost to access powerful systems and software, barriers to entry also decrease. Firms need to think about the strategic advantages they can create, even as technology is easily duplicated. This trend means the potential for more new entrants across industries, and since startups can do more with less, it's also influencing entrepreneurship and venture capital. The CTO of SlideShare, a startup that launched using Amazon's S3 storage cloud, offers a presentation on his firm's site labeled "Using S3 to Avoid VC". Similarly, the CEO of online payments startup Zuora claims to have saved between half a million and one million dollars by using cloud computing. "We have no servers, we run the entire business in the cloud"[65]. And the sophistication of these tools lowers development time. Enterprise firm Apttus claims it was able to perform the equivalent of six months of development in a couple of weekends by using cloud services. The firm scored its first million dollar deal in three months, and was break-even in nine months, a ramp-up time that would have been unheard of, had they had to plan, purchase, and deploy their own data center, and create from scratch the web services that were provided by its cloud-vendor[66].

So, what's it take to run this thing?

In the countryside surrounding the Columbia River in the Pacific Northwest, potato farms are yielding to server farms. Turns out the area is tailor made for creating the kinds of massive data installations that form the building blocks of cloud computing. The land is cheap, the region's hydroelectric power costs a fraction of Silicon Valley rates, and the area is served by ultra-fast fiber-optic connections. Even the area's mild temperatures cut cooling costs.

Most major players in cloud computing have server farms in the region, each with thousands of processors humming away simultaneously. Microsoft's Quincy, Washington facility is as big as 10 American football fields and has nearly 600 miles of wiring, 1.5 metric tons of battery backup, and 3 miles of chiller piping to keep things cool. Just a short drive away, Yahoo has two facilities on 50 acres, including one that runs at a zero carbon footprint. Google has a 30-acre site sprawled across former

[63] Mehta, 2006
[64] Fortt, 2009b
[65] Ackerman, 2008
[66] Rayport, 2008

farmland in The Dalles, OR. The Google site includes two massive buildings, with a third on the way. And in Boardman, OR, Amazon has a three building petabyte palace that sports its own 10 megawatt electrical substation[67].

While U.S. activity has been particularly intense in the Pacific Northwest, server farms that support cloud computing are popping up from Shanghai to Sao Paulo. Not only does a diverse infrastructure offer a degree of fault tolerance and disaster recovery (Oregon down? Shift to North Carolina), the myriad of national laws and industry-specific regulatory environments may require some firms to keep data within a specific country or reason. To meet the challenge, cloud vendors are racing to deploy infrastructure worldwide and allowing customers to select regional availability zones for their cloud computing needs.

The build-out race has become so intense that vendors including Sun, Microsoft, IBM, and HP have all developed rapid-deployment server farm modules that are pre-configured and packed inside shipping containers. Some of these units contain as many as 3,000 servers each. Just drop the containers on site, link to power, water, and telecom, and presto - you've got yourself a data center. More than 200 containers can be used on a single site. Microsoft VP Debra Chrapaty says the configuration has cut the time to open a data center to just a few days, claiming Microsoft's San Antonio facility was operational in less time than it took a local western wear firm to deliver her custom-made cowboy boots![68]

A Sun server-packed container designed for rapid data center deployment (source: J. Gallaugher)

While firms are buying less hardware, cloud vendors have turned out to be the computing industry's best customers. Amazon has spent well over $2 billion on its cloud infrastructure. Google reportedly has 1.4 million servers operating across three-dozen data centers[69]. Demonstrating it won't be outdone, Microsoft plans to build as many as 20 server farms, at costs of up to $1 billion each[70]. Look for the clouds to pop up in unexpected places. Microsoft has scouted locations in Siberia, while Google has applied to patent a method for floating data centers on an offshore platform powered by wave motions.[71]

KEY TAKEAWAYS:

- Clouds can lower barriers to entry in an industry, making it easier for startups to launch and smaller firms to leverage the backing of powerful technology.

[67] Katz, 2009
[68] Burrows, 2008
[69] Katz, 2009
[70] Burrows, 2008
[71] Katz, 2009

- Clouds may also lower the amount of capital a firm needs to launch a business, shifting power away from venture firms in those industries that had previously needed more VC money.
- Clouds can shift resources out of capital spending and into profitability and/or innovation.
- Hardware and software sales may drop as cloud use increases, while service revenues will increase.
- Tech skills in datacenter operations, support, and maintenance may shrink as a smaller number of vendors consolidate these functions. Tech managers will need even stronger business skills and will focus an increasing percentage of their time on strategic efforts. These latter jobs are tougher to outsource, since they involve an intimate knowledge of the firm, its industry, and its operations.

VIRTUALIZATION: SOFTWARE THAT MAKES ONE COMPUTER ACT LIKE MANY

The reduced costs and increased power of commodity hardware are not the only contributors to the explosion of cloud computing. The availability of increasingly sophisticated software tools has also had an impact. Perhaps the most important tool in the toolbox is *virtualization* software. Think of virtualization as being a kind of operating system for operating systems. A server running virtualization software can create smaller compartments in memory that each behave as separate computer with its own operating system and resources. The most sophisticated of these tools also allow firms to combine servers into a huge pool of computing resources that can be allocated as needed[72].

Virtualization can generate huge savings. Some studies have shown that on average, conventional data centers run at 15 percent or less of their maximum capacity. Data centers using virtualization software have increased utilization to 80 percent or more[73]. This increased efficiency means cost savings in hardware, staff, and real estate. Plus it reduces a firm's IT-based energy consumption, cutting costs, lowering its carbon footprint, and boosting "green cred"[74].

While virtualization is a key software building block that makes public cloud computing happen, it can also be used in-house to reduce an organization's hardware needs, and even to create a firm's own private cloud of scalable assets. Bechtel, BT, Merrill Lynch, and Morgan Stanley are among the firms with large private clouds enabled by virtualization[75]. Virtualization can even live on your desktop. Anyone who's ever run Windows in a window on Mac OS X is using virtualization software; these tools create a chunk of your Mac's memory that's actually fooled into thinking it's a PC.

Interest in virtualization has exploded in recent years. VMWare, the virtualization software division of storage firm EMC, was the biggest IPO of 2007. But its niche is getting crowded.

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[72] Lyons, 2008
[73] Katz, 2009
[74] Castro, 2007
[75] Brodkin, 2008

Microsoft has entered the market, building virtualization into its server offerings. Dell bought a virtualization software firm for $1.54 billion. And there's even an open source virtualization product called Xen[76].

KEY TAKEAWAYS

- Virtualization software allows one computing device to function as many. The most sophisticated products also make it easy for organizations to scale computing requirements across several servers.
- Virtualization software can lower a firm's hardware needs, save energy, and boost scalability.
- Data center virtualization software is at the heart of many so called private clouds, scalable corporate data centers, as well as the sorts of public efforts described earlier.
- Virtualization also works on the desktop, allowing multiple operating systems (Mac OS X, Linux, Windows) to run simultaneously on the same platform.

MAKE, BUY, OR RENT

So now you realize managers have a whole host of options when seeking to fulfill the software needs of their firms. An organization can purchase packaged software from a vendor, use open source offerings, leverage SaaS or other type of cloud computing, outsource development or other IT functions to another firm either domestically or abroad, or a firm can develop all or part of the effort themselves. When presented with all of these options, making decisions about technologies and systems can seem pretty daunting.

First, realize that that for most firms, technology decisions are not binary options for the whole organization in all situations. Few businesses will opt for an IT configuration that is 100 percent in-house, packaged, or SaaS. Being aware of the parameters to consider can help a firm make better, more informed decisions. It's also important to keep in mind that these decisions need to be continuously reevaluated as markets and business needs change. Here's a summary of variables to consider:

- **Competitive Advantage** – *Do we rely on unique processes, procedures, or technologies that create vital, differentiating competitive advantage?* If so, then these functions aren't a good candidate to outsource. Amazon.com had originally used recommendation software provided by a third-party, and Netflix and Dell both considered third-party software to manage inventory fulfillment. But in all three cases, these firms felt that mastery of these functions was too critical to competitive advantage, so each firm developed proprietary systems unique to the circumstances of each firm.
- **Security** – *Are there unacceptable risks associated with using the packaged software, OSS, cloud solution, or outsourcing vendor? Are we convinced that the prospective solution is sufficiently secure and reliable? Can we trust the prospective vendor with our code, our data, our procedures and our way of doing business? Are there non-compete provisions for vendor staff that may be privy to our secrets? For off-site work, are there sufficient policies*

[76] Castro, 2007

in place for on-site auditing? If the answers to any of these questions is no, outsourcing is not a viable option.

- **Legal and compliance** – *Is our firm are prohibited outright from using technologies? Are there specific legal and compliance requirements related to deploying our products or services?* Even a technology as innocuous as instant messaging may need to be deployed in such a way that it complies with laws requiring firms to record and reproduce the electronic equivalent of a paper trail. For example, SEC Rule 17 (a) 4 requires broker dealers to retain client communications for a minimum of 3 years. HIPAA laws governing healthcare providers state that electronic communications must also be captured and stored[77]. While tech has gained a seat in the board room, legal also deserves a seat in systems planning meetings.
- **Skill, Expertise, and Available Labor** – *Can we build it?* The firm may have skilled technologists, but they may not be sufficiently experienced with a new technology. Even if they are skilled, managers much consider the costs of allocating staff away from existing projects for this effort.
- **Cost** – *Is this a cost effective choice for our firm?* A host of factors must be considered when evaluating the cost of an IT decision. The costs to build, host, maintain, and support an ongoing effort involve labor (software development, quality assurance, on-going support, training, and maintenance), consulting, security, operations, licensing, energy, and real-estate. Any analysis of costs should consider not only the aggregate spending required over the lifetime of the effort but also whether or not these factors might vary over time.
- **Time** – *Do we have time to build, test, and deploy the system?*
- **Vendor Issues** – *Is the vendor reputable and in a sound financial position? Can the vendor guarantee the service levels and reliability we need? What provisions are in place in case the vendor fails or is acquired? Is the vendor certified via the Carnegie Mellon Software Institute or other standards organizations in a way that conveys quality, trust, and reliability?*

The list above is a starter. It should also be clear that these metrics are sometimes quite tough to estimate. Welcome to the challenges of being a manager! At times an environment in flux can make an executive feel like he or she is working on a surfboard, constantly being buffeted about by unexpected currents and saves. Hopefully the issues outlined in this chapter will give you the surfing skills you need for a safe ride that avoids the organizational equivalent of a wipeout.

KEY TAKEAWAYS

- The make, buy, or rent decision may apply on a case-by-case basis. Firm and industry dynamics may change in a way that causes firms to reassess earlier decisions, or to alter the direction of new initiatives.
- Factors that managers should considered when making a make, buy, or rent decision include: competitive advantage, security, legal and compliance issues, the organization's skill and available labor, cost, time, and vendor issues.
- Factors must be evaluated over the lifetime of a project, not at a single point in time.

[77] Shapiro, 2004

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This reading is available to faculty for non-commercial use. Enjoy! If you do use it, please send an e-mail to john.gallaugher@bc.edu. More chapters and cases will follow in Professor Gallaugher's forthcoming book "Information Systems: A Manager's Guide to Harnessing Technology", to published (in both free online and low-cost print version) by Flat World Knowledge (FlatWorldKnowledge.com). Thanks!

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