

# CHAPTER 1

## A Cloudy Forecast

The cloud—shorthand for “cloud computing”<sup>1</sup>—is transforming all spheres of our world: commerce, entertainment, culture, society, education, politics, and religion. Cloud start-ups are forming on a daily basis, and billions of dollars in wealth are being created as companies craft innovative strategies to exploit this opportunity. Conversely, long-standing corporate icons that have failed to do so are becoming history instead of making it.

The concept of a public cloud—shared, on-demand, pay-per-use resources, accessible over a wide-area network, available to a broad range of customers—might appear to be a recent breakthrough, but there is nothing new under the sun, not even the cloud. The ancient Romans implemented the information superhighway of their time, constructing an unprecedented wide-area network with thousands of route miles of roads, called *viae*, using state-of-the-art engineering, following documented standards.<sup>2</sup> The public network, made of public roads, or *viae publicae*, was complemented by and interoperable with metro networks, the *viae vicinales*, and private networks, the *viae privatae*, creating an Internet of sorts. The roads of the Romans carried people, goods, and soldiers, but, perhaps most important, they also served as a communications network, enabling information, coordination, and control of the far-flung republic and then empire.

These *viae* were multiprotocol networks—carrying pedestrians, animals, carts, military chariots, horses, and their riders—with class of service—military and chariots in the center lane, pedestrians and slower vehicles to the side.<sup>3</sup> Net neutrality was assumed: Any citizen could traverse the *viae publicae* and even had certain rights of passage on the *viae privatae*.<sup>4</sup> By order of Caesar, the core of the network had congestion management: Transport carts were banned from the network core—the narrow, winding streets at the heart of Rome—from dawn until dusk.<sup>5</sup> A complementary architecture was used for streaming content delivery: the aqueducts.

A variety of service providers—inns, taverns, posthouses, and the like—became embedded in the fabric of this network, offering value-added services. Each inn—called a *caupona*—offered lodging to travelers on an on-demand, pay-per-use basis: The traveler merely showed up, stayed, and paid. The inns serviced different classes of customers, from peasants to citizens and free men, and there were laws concerning security and limitations of liability. According to an edict issued by the *praetor*, a senior regulatory official of the time, the proprietor, or *caupo*—the cloud service provider of the age—was responsible for ensuring that the traveler's belongings were neither stolen nor damaged while resident at the service provider's facility.<sup>6</sup> Acts of the gods, such as fires, were excluded. Authentication, via the presentation of credentials or tokens, *tesseræ hospitalitatis*, was required before service could be rendered.<sup>7</sup> Advertising and branding were important even then. In ancient Pompeii, the Elephant Inn had a logo: a painting of a pygmy defending an elephant entrapped by a snake. The signage also offered capacity status updates: *hospitium hic locatur* (i.e., “inn to let”).<sup>8</sup>

Even before Rome, the Greeks had inns, the Persians had public roads, the Assyrians had aqueducts,<sup>9</sup> the Babylonians extended credit, and over 4,000 years ago, during the dawn of Western civilization in Sumeria, the advanced production, facilities, and power technologies of the time—farm implements, water rights, and oxen—were offered for access under a pay-per-use model: leasing. Thousands of years later, in the Middle Ages, knights' armor—the intrusion-prevention hardware of the time—was also leased.<sup>10</sup> It can even be argued that key elements of today's cloud computing environments have been anticipated by early biological systems: ant colonies will determine the shortest path to “content,” such as sources of food, and exhibit behavioral plasticity, that is, will dynamically allocate resources—worker ants—to foraging, patrolling, nest maintenance, and midden work, that is, refuse pile maintenance.<sup>11</sup>

## Clouds Everywhere

---

This proven architectural and business model, since applied to modern hotels, electricity, coffee shops, taxi fleets, rental car services, and others, has now come to computing, and in computing—as in meteorology—the cloud these days is covering a lot of ground. Now, as never before, information technology (IT) and cloud computing are having a broad impact.

The cloud is pervading the prosaic patterns of everyday existence. Teens, tweens, and even toddlers are tapping on touch screens or thumb-typing text messages. Even untethered applications, or “apps,” need to be purchased and downloaded via a cloud-based app store, but, more

important, many applications require additional cloud-based services to function. Natural-language interfaces are enabled by cloud-based speech processing and semantic analysis; search requires the near-infinite processing and storage power of the cloud; social gaming is mediated via the cloud; high scores are uploaded to the cloud; apps and content are updated from the cloud; and status updates, files, photos, videos, reviews, and check-ins are shared via the cloud.

The cloud complements the consumerization of IT, and broadens and deepens its democratization. Businesses used to dictate the desktop, laptop, and software used by employees. But if applications in the cloud process data in the cloud, “bring your own device” is a viable strategy—if not without security and interoperability concerns—potentially reducing corporate expenditures while enabling consumer-employees to make fashion and status statements as well as live a blended work-family lifestyle. Democratization of IT means that not only device access but the creation and modification of applications can expand beyond the IT shop, unleashing a torrent of innovation and motivation through empowerment.

Gaming is moving to the cloud as well. Traditionally, you bought a console and cartridges or discs at a physical store. Then you could order over the Web. Then you could take delivery over the Web, via game downloads from an app store. Then you could use your console over the Internet, with up to four-fifths of gamers using connected consoles to play online, download games, or chat.<sup>12</sup> Now, with “cloud gaming,” even high-performance games—formerly requiring advanced consoles built to exploit state-of-the-art computing engines—are being played in real time *on* the net *over* even 3G networks, with polygons and video generated remotely but displayed on relatively low-performance endpoints, such as smartphones.<sup>13</sup> It would be a mistake to consider gaming merely to be the province of, say, 14- to 24-year-old males. Gaming is not only popular across many demographics, but represents the state of the art in everything from interfaces to performance that will trickle down into more mundane business applications. Moreover, “games” can represent a new era in collaboration: A long-standing problem in HIV research—the protein structure of the Mason-Pfizer monkey virus retroviral protease—was recently solved by global players of the online game Foldit, illustrating “the power of online games to channel human intuition and three-dimensional pattern-matching skills to solve challenging scientific problems.”<sup>14</sup>

The conduct of commerce is undergoing a revolution, with new players in online retailing, group coupons, video distribution, and blogging—to name a few—dramatically disrupting market ecosystems and driving long-established players out of business, while creating fortunes for some in the process. Behind the scenes, cloud-based collaboration, innovation markets, and contests are enabling companies to tap into the smartest and most

creative minds in any field, regardless of geographic location. Procter & Gamble explained the straightforward math<sup>15</sup>: Fewer than 10,000 researchers *within* the firm, 1.5 million *outside*. Or let's go beyond blue-chips: Sites like Mom Invented, which let moms go to market with mechanisms to prevent kids from unrolling toilet paper, are, well, on a roll.<sup>16</sup>

In short, the cloud is disrupting every dimension of business, whether it is the research, engineering, or design of new products and services; their manufacturing, operations, and delivery; or any point along the customer interface and its myriad moments of truth<sup>17</sup>—branding, awareness, catalog, trial, customization, order processing, delivery, installation, support, maintenance, or returns.

Consider the customer engagement life cycle and how IT and the cloud can play a role. Positioning, branding, and advertising today often require social media, and product positioning and customer awareness require trials, demos, and virtual tours. In developing solutions to meet customer requirements, cloud-mediated collaboration such as telepresence, 3-D models, electronic whiteboards, and contests can be vital. For product delivery, mobile tracking and installation support are needed. For service delivery, content delivery networks and continuous online connections can be essential. Billing and payment have gone online and mobile. Support and repair can be handled by user-driven knowledge bases, frequently asked questions (FAQs), and online chat. And the returns and recycling processes are being augmented by collaborative consumption, which is creating a cloud-enabled means of recycling, well, everything.<sup>18</sup> This includes eBay but also a plethora of niche sites.

The cloud can be used to cut costs and to create value. *The New York Times* digitized archival copies of the paper from 1851 to 1980 for customer Web retrieval and was able to convert 11 million articles in less than a day for less than \$1,000.<sup>19</sup> *The Washington Post* managed to process 17,481 pages of Hilary Clinton's daily schedule as First Lady in nine hours, for a cost of \$144.62.<sup>20</sup> The cost reduction is useful, but these cases are more interestingly viewed in terms of unlocking hidden value and creating a time advantage for reporters to search for scoops. Moreover, the fact that IT was bypassed is both a threat to legacy organizations and an example of the empowerment created by the democratization of IT.

The cloud is also radically reshaping the relationship among governments, the governed, and nongovernmental organizations, impacting regional balances of power and global stability. Arguably the most powerful man on earth—the President of the United States—has had to enlist Twitter to achieve his political objectives. Meanwhile, other world leaders are in prison, or worse, due to movements initiated and coordinated through cloud-based social networks. Throughout history, there has been an asymmetry between governments—organized megaliths with hierarchical,

sometimes autocratic control structures—and their citizens—disorganized, incoherent, Brownian agglomerations with severely limited ability to exert influence, restricted to opinion polls, letter writing, and the occasional election of representatives. And that's in the best case. But increasingly, social media are enabling disparate individuals to behave as a coordinated population, the way that a single action potential—a neuronal voltage spike—can organize individuated muscle cells to throw a knockout punch.

These same trends are rewriting the rules for waging warfare: Why launch missiles when a government—or its agents—can accomplish the same result via an anonymous cyberattack and walk off scot-free? The *entire country* of Estonia—called the “most wired” in Europe—was taken off the net for days, apparently in response to its removal of a commemorative statue from a square a few days earlier.<sup>21</sup> As a result, cyberspace has now become the fifth domain of military operations: after land, sea, air, and space.<sup>22</sup>

U.S. Army General Keith Alexander, head of the U.S. Cyber Command, recently warned that in the future, we can expect cyberattacks to cause power outages and physical destruction.<sup>23</sup> We may not need to wait until the future: The Stuxnet computer worm appears to have been specifically engineered to wreak havoc in Iran's Bushehr nuclear complex, targeting the programmable logic controllers that run advanced machinery.<sup>24</sup> By rapidly speeding up and slowing down nuclear centrifuges, it may have caused thousands of them to blow apart.<sup>25</sup>

The United States has unequivocally stated its policy regarding such cyberattacks: According to the International Strategy for Cyberspace, “the United States will respond to hostile acts in cyberspace as we would to any other threat to our country. We reserve the right to use all necessary means—diplomatic, informational, military, and economic—as appropriate and consistent with applicable international law, in order to defend our Nation, our allies, our partners, and our interests.”<sup>26</sup> In other words, a war beginning in the computing cloud might end in a mushroom cloud.

Education is evolving. The Massachusetts Institute of Technology (MIT) was a pioneer in offering Open Course Ware a decade ago, by posting lecture notes on the Web and permitting professors' lectures to be posted as videos. Recently, MIT found a way to leverage the cloud further, by launching MITx, an approach that includes self-paced learning but also interactive online labs and student collaboration and interaction.<sup>27</sup> In an example of MIT deep thinking, it is planning not only to gather research data from the initiative but also to market the underlying platform.

Religion is reforming. By leveraging the social media and information technology of the day—printing—Martin Luther's message, the “95 Theses,” was, in effect, retweeted, ultimately driving the Protestant Reformation. Then, as now, short was sweet: Pamphlets could be read and reproduced more quickly than books, causing his message to spread like wildfire.<sup>28</sup>

Today, religion is relocating online: Various sites let users search for prayers by topic, submit prayer requests by e-mail, or meet like-minded singles.

The cloud is impacting and challenging privacy, regulation, and law. How exactly does the USA PATRIOT Act impact a German company hosting Canadian data on U.S. soil? Did any U.S. senators influence Amazon's decision to stop hosting WikiLeaks?<sup>29</sup> Is broadband access a basic human right, as the United Nations International Telecommunications Union Broadband Commission argues?<sup>30</sup> Finland thinks so, mandating 1 megabit-per-second (mbps) access for all 5 million plus citizens, with a 100-mbps minimum soon to follow.<sup>31</sup> Who exactly will pay for these "rights," which account for a substantial fraction of the \$300 to \$400 *billion* dollars of capital that telecommunications firms invest *annually*? According to Christopher Yoo, a professor of law and director of the Center for Technology, Innovation & Competition at the University of Pennsylvania, the rapid emergence of the cloud is rapidly outpacing a legal and regulatory system designed for an earlier age.<sup>32</sup>

Author and Wharton lecturer Jeremy Rifkin has argued that there are deep cultural trends at work here, as we transition from a capitalist age of ownership and thus markets to an Age of Access. Why waste money and space on owning goods if you can access the benefit that the goods offer? You don't want to own a DVD, you want access to the emotion, engagement, and entertainment that watching a movie can bring. Authors and innovators Rachel Botsman and Roo Rogers have proposed that the dissolution of ownership and the possibilities engendered by the cloud can give rise to an era of collaborative consumption, where goods may be recycled from one "owner" to the next, with such transactions managed via the cloud. I'll trade you my used DVD for your used book. At BookMooch.com—"Give books away. Get books you want."<sup>33</sup>—you type in the title of a book that you have but no longer want, someone else requests it, and you send it to them to earn points, which can then be used to "purchase" other books. Meanwhile, BookMooch uses Twitter as a book status broadcasting medium, indicating, for example, that "The Client: John Grisham" is now available.<sup>34</sup> Services such as SnapGoods—"Want It. Get It. Give It Back"—SwapStyle—the "number 1 fashion swap site" and Airbnb—which lets people "rent from real people in 19,732 cities in 192 countries"—are enabling peer groups of individuals to collectively behave as large service providers or even retailers.<sup>35</sup>

## Cashing In on the Cloud

---

These trends, issues, and opportunities are universal: Is there *anyone* left on the *planet* who doesn't use either Google or Groupon; Facebook or

Foursquare; Yahoo! or YouTube; AOL or Amazon; Twitter or Tencent; or their equivalents? Who doesn't use at least one of e-mail, text messaging, music downloads, music streaming, video streaming, file backup, file sharing, voicemail, telephony, Voice over Internet Protocol (VoIP), instant messenger, video chat, Web meetings, wireless photo frames, netcams, online games, video telepresence, or similar technologies for communications, search, news, weather, gaming, entertainment, shopping, package tracking, hurricane tracking, price comparisons, daily deals, navigation based on real-time congestion, hot bar and restaurant check-ins, or just to launch irate fowls on parabolic arcs to destroy the dwellings of swine or whatever else it is that the hundreds of thousands of apps available from cloud-based online stores do?

Such widespread adoption, in the latest example of Schumpeterian creative destruction, has created immense wealth for vendors, service providers, and other market participants across the cloud ecosystem. This ecosystem comprises endpoints, such as smartphones and tablets but also televisions, sensors, and digital signs; the broadband mobile and fixed networks that carry traffic to and from the cloud; the cloud services and infrastructure required to deliver them; and vendors products and services embedded inside this infrastructure.

For a variety of companies, the cloud is not just *strategic* but *existential*. Some firms owe their very existence to the cloud, whether they call it that or not. Others can blame their demise to a failure to formulate effective cloud strategies. As Amazon accelerated to a market capitalization of over \$80 billion, Borders Books became bankrupt. While Google searched for—and found—growth, rapidly returning results that include nearly \$20 billion in gross profits on just over \$35 billion in revenue annually, leading to a \$200 billion market cap, numerous newspapers folded. As Apple's iTunes became a juicy hit, Tower Records tumbled. And as Salesforce.com sold customers on its approach, Siebel sagged.<sup>36</sup>

Companies that didn't even exist a few years ago now have market capitalizations of tens or hundreds of billions of dollars. Although some of this value may be a replay of the irrational exuberance of the dot-bomb era, much of it represents a rational valuation of irreversible secular trends: from atoms to bits, from the age of capitalism to the age of access, and from IT as a topic for academics and engineers to a main focus in the boardroom.

It seems that everyone is exploiting, or at least examining, the cloud. Amazon, BMC, CA Technologies, Cisco, Citrix, Dell, EMC, Facebook, Google, HP, IBM, Juniper, Microsoft, NetApp, Oracle, VMware, and Yahoo!, of course. But you don't need to be a traditional IT player: Walmart is increasingly complementing its Supercenters with Walmart.com. Global telcos—AT&T, Verizon, and BT—and smaller regional ones—Turkcell and Ibermatica, for example—are pursuing their cloud strategies. Barnes &

Noble is designing and distributing computing devices: the NOOK eReaders. Con Edison is becoming a smart-grid utility. Pfizer has moved half its workloads to the cloud. Eli Lilly recently ran a complex 64-processor bioinformatics task at a cost of just over \$6, not much more than a burger and a soda.<sup>37</sup>

## Beyond Business

---

If you are reading this book, you probably already know that such applications must be delivered out of enormous data centers, the size of one or more football fields, specially sited based on low power and cooling costs, leveraging state-of-the-art broadband fiber and fourth-generation networks that connect such data centers to advanced technology endpoints such as high-definition smartphones and tablets. Or must they?

In fact, while you may think of these as advanced applications only for use in the developed world, emerging affordable mobile technologies, hardened, containerized data centers, and new middle earth orbit satellites will enable cloud-based applications *just about anywhere in the world*. It's not just smartphones that can sit in the palm of your hand; new technologies can place a wireless base station—formerly the size of a closet, if not a car—into that same palm. Alcatel-Lucent, for example, recently announced its lightRadio device, which looks like a bronze Rubik's cube but can process thousands of simultaneous cell phone calls over a multisquare-mile area and fit in your pocket.<sup>38</sup>

Solar-powered data centers in power-efficient containerized pods coupled with these mobile technologies mean that cloud services can be dropped into the middle of nowhere and provide end-to-end services: endpoint, network, and cloud, *even if there is a complete lack of power and network infrastructure*. Even without these advances, cloud-based services are already driving a dramatic transformation of all aspects of economy and society globally.

Examples from India, Japan, and Kenya show the breadth of applicability of a wide variety of services using a variety of cloud-based technologies.

In India, the fishermen of Kerala would arrive at various coastal markets at dawn with their catch, only to find that there was a glut—other fishermen had already arrived at those markets with *their* catch, and customers had already bought their desired quantity. Due to the lack of refrigeration, they would have to sell their fish at well-below-market prices or throw it away.

The advent of mobile telephony and short message service (SMS), that is, texting, which broadly speaking are cloud services, transformed this situation.<sup>39</sup> Once fishermen could determine which coastal markets would



offer the best price and assess price differentials in light of fuel costs, shortages and surpluses were dramatically reduced. In short, the cloud can enable the proper and efficient functioning of even the simplest markets.

In Miyakonojo, in Miyazaki Prefecture, Japan, Shinpuku Seika is a “farm,” actually comprising 300 individual plots across almost 250 acres. Using several cloud-based and mobile/wireless technologies, a variety of capabilities have been implemented that have increased crop yields and therefore revenues and profitability.<sup>40</sup> Wireless temperature and humidity sensors deployed throughout the acreage determine which plants need more irrigation. Mobile cameras are used to capture videos of potentially diseased crops for review by horticultural experts. Mobile tracking technology ensures that farmhands do not fall asleep in the fields.

Joe Pine and James Gilmore, authors of *The Experience Economy*, have posited that there is an evolution of business value under way: from commodities, to products, to services, to experiences, and ultimately to transformations.<sup>41</sup> For example, coffee beans are a commodity, priced lower than a product such as packaged coffee, which is priced lower than a service from a coffee shop, which is priced lower than an “experience,” such as dining in a chic café. Each of these drives higher value and thus revenue and margin. The price of the coffee in a cup might be pennies as beans, a dime or two packaged and branded on your store shelf, a few dollars at a coffee shop, and \$10 or more consumed on the Champs-Élysées. Pine and Gilmore suggested that commodities are extracted, products are manufactured, and services are delivered, but experiences are *staged*.

At the top of their hierarchy are customized experiences leading to individual transformations, where “the customer is the product.” These are experiences offering not only ephemeral enjoyment and entertainment but a transformation of the individual: a fitness membership, a graduate education, or life-saving surgery.

Cloud services are offering increasingly engaging experiences, ranging from immersive games exploiting motion sensing, video compositing, and virtual and augmented reality, to telepresence and even virtual worlds. But perhaps we can extend Pine and Gilmore’s “transformations” even further, beyond individuals into societies. Such social transformation may be viewed as good business—“doing well by doing good”—supporting communities through sustainability, charity, and educational efforts. However, beyond the realm of business, there is no doubt that “social transformation” encompasses more than mere commercial experiences and sets the context for the society in which business must operate and individuals must live.

In Kenya, Ushahidi was cofounded by Juliana Rotich, currently executive director of the organization, to enable anyone with a basic mobile phone to easily report geo-tagged information and in turn get alerted to the status of a given area.<sup>42</sup> Originally deployed after contested elections and

official government reporting of questionable accuracy, Ushahidi has allowed ordinary citizens in dozens of countries to become better informed and thus better protected from political unrest, crime, or natural disaster.

Ushahidi originally required a software install but has since evolved to a fully cloud-based solution called Crowdmap. As a result, ease of use has been enhanced, and Crowdmap can be—and has been—rapidly deployed for emergencies such as the Haitian earthquake relief effort.

According to Rotich, several principles are at the core of Ushahidi/Crowdmap:

- A nonhierarchical *community* forming around an issue, such as crimes or election results
- *Sharing*, via not just the Web but SMS and e-mail and coupled with routing and analysis
- *Collaboration*, such as matching those who need assistance with those who can offer it
- *Context*, for example, acquiring, filtering, and presenting information based on location

It's not just nongovernmental agencies that are creating societal value. The City of Miami has built a similar system using cloud technologies, enabling residents to view nonemergency requests graphically on a map. Instead of a multi-month development and implementation time, the city was able to prototype the system in a week.<sup>43</sup>

And, according to John Dillon, chief executive officer of Engine Yard, cloud-based platform as a service offers not just a cost and time reduction benefit for IT operations but has real social impact as well.<sup>44</sup> For example, Case Commons used Engine Yard to deploy an innovative application called Casebook to provide cutting-edge, Web-based technology to replace public, state-level, child welfare enterprise systems. Such systems have the potential to help thousands of children in the U.S. foster care system.

Some governments are finding that the cloud can be essential to achieving social transformation via political means. At just after 4 P.M. on the afternoon of Tuesday, December 20, 2011, with most of Congress already home or headed that way for the holidays, in an attempt to force a divided Congress to pass a two-month extension to payroll tax cut legislation, U.S. President Barack Obama (@BarackObama) and the White House (@WhiteHouse) tweeted “What does #40dollars mean to you?” accompanied by a photo of two twenty dollar bills.<sup>45</sup>

Less than 72 hours later, the president signed the extension into law, after gaining the “unanimous consent” of Congress.<sup>46</sup> Seventy-two hours! Who has ever heard of any organization, much less government, moving that quickly? Forget e-government, we have entered the age of

c-government: government of the people, by the people, for the people, via the cloud.

Conversely, other leaders are finding that the cloud has not been their friend, enabling populations with long-simmering issues to amplify their anger and coordinate their actions.

Facebook and Twitter have been credited with enabling the Arab Spring of peaceful—and not-so-peaceful—regime change from autocratic leadership toward greater freedom and democracy. According to the *Arab Social Media Report* from the Dubai School of Government, 90% of “Egyptians and Tunisians . . . were using Facebook to organize protests or spread awareness about them.”<sup>47</sup>

There is also a more sinister side: the BlackBerry Messenger—enabled London flash mobs during the summer 2011 riots.<sup>48</sup> In any case, there is no doubting the power of today’s technology. Cloud-based social networks, microblogs, and messaging services are having an impact as great as Paul Revere’s midnight ride or the invention of gunpowder.

These megatrends and specific examples—India, Japan, and Kenya; Washington, D.C., London, and Cairo; Facebook, Twitter, and Angry Birds—all have the cloud in common. Given the importance of such services, you might think that all the kinks have been worked out, especially since issues in IT delivery are no longer just IT problems but corporate brand problems, leading to immediate loss of revenue, negative publicity and thus loss of brand equity, and customer churn. Well-publicized outages occasionally occur, however, these are likely to be growing pains, not insurmountable barriers, and an increasing number of customers and users are using the cloud in some fashion.

## Clarifying the Cloud

---

What in the world is the cloud? Although there is perhaps no term with as many definitions, for this book we define the cloud with a helpful mnemonic, C.L.O.U.D., reflecting five salient characteristics:

**C**ommon infrastructure  
**L**ocation independence  
**O**nline accessibility  
**U**tility pricing  
**o**n-**D**emand resources

It is *common*, in that it uses pooled resources and dynamically shared infrastructure; *location-independent*, in that the service should be ubiquitous and responsive; *online*, that is, accessed over a network; a *utility*, creating

value and with usage-sensitive pricing; and *on-demand*, that is, with the right quantity of the right resources available exactly and only when needed.

Some of the behind-the-scenes technologies supporting cloud computing are relatively new—for example, virtualization and automated bare-metal provisioning. This book does *not* delve into these assorted technologies. What we do investigate is the universal principles that have applied since the Roman Republic and are applicable to today’s businesses.

These principles are applicable to the ancient *caupona*e and today’s hotel chains, taxi fleets, airlines, electric utilities, and lenders. Hotels offer “utility,” “pay-per-use,” or “usage-sensitive” pricing: More rooms for more nights cost more. Electric utilities and taxi companies offer “on-demand” service—flick a switch or raise your hand and service magically appears. Whether data networks, the electric grid, or highways including the Appian Way, online networks make resource sharing and thus pay-per-use possible. And global dispersion—whether content delivery networks or thousands of corner coffee shops—ensures that location does not matter in meeting user experience targets.

## Farther On

---

This book is written somewhat sequentially, but there is no reason not to jump straight to a chapter that is of interest as chapters are largely self-contained.

In the next few chapters, we look at IT and cloud computing in the context of competitive strategy and explore different use cases for which the cloud is particularly well suited—and those for which it is not. A review of the conventional wisdom regarding the cloud should help puncture some common myths—or at least make you think twice.

We look at the properties of pay-per-use pricing and on-demand resources, the conditions under which such charging and provisioning drive value—various combinations of unpredictability and variability—and architectural implications.

We examine the increasing importance of proximity, and the economics of dispersion in enhancing the user experience, then delve into the trade-offs between consolidation and dispersion and thus between processing time reduction and latency reduction.

We touch on behavioral economic concerns for and against cloud adoption, skimming the surface of the rich and often surprising field at the intersection of psychology, neuroscience, and economics.

We delve more deeply into advanced valuation of cloud patterns such as communications and markets, considering not just cost but topics such as the expected marginal value of an additional participant in a market.

Finally, we wrap our discussion up and draw conclusions regarding the evolution of cloud technology and the cloud ecosystem. The next decade is likely to bring untold innovation: as Don Tapscott, consultant, best-selling author, and an adjunct professor at the University of Toronto's Rotman School of Management, has claimed, "The cloud is becoming a global computation platform—a computer of sorts—and every time we use it we program it."<sup>49</sup>

## Summary

---

The core ideas behind the cloud business model may be thousands of years old, but cloud *computing* is new and transforming all aspects of personal life, business, and society. The most exciting thing about the cloud is in how it can create value and transform traditional economic assumptions. For example, companies have challenges in managing variable and unpredictable demand. Traditional approaches shifted the locus of the problem without addressing it in any way, much like blowing your fallen leaves onto your neighbor's lawn. However, the cloud creates genuine economic value in unique ways. The interplay between multiple customers and one or more cloud service providers ameliorates many challenges facing companies today. We explore everything from strategy to statistics in the coming chapters.

## Notes

---

1. Some differentiate between "cloud computing" and "cloud services." These distinctions are largely unnecessary for the purposes of this book.
2. Roads were to be 8 feet wide if straight, 16 feet if curved. Gregory Aldrete, *Daily Life in the Roman City: Rome, Pompeii and Ostia* (Greenwood, 2004), p. 36.
3. William Kaszynski, *The American Highway: The History and Culture of Roads in the United States* (McFarland & Company, 2000).
4. Adolf Berger, "Encyclopedic Dictionary of Roman Law," *Transactions of the American Philosophical Society* 32, Part 2 (1953): 763.
5. Jerome Carcopino, *Daily Life in Ancient Rome* (Yale University Press, 1940), p. 49.
6. Sir William Smith, ed., *Dictionary of Greek and Roman Antiquities*, 2nd ed. (Taylor and Walton, 1848), p. 258.
7. W. C. Firebaugh, *Inns of Greece and Rome* (Benjamin Blom, 1928), p. 41.
8. August Lau, *Pompeii: Its Life and Art* (Macmillan, 1899), p. 392.
9. Peter J. Aicher, *Guide to the Aqueducts of Ancient Rome* (Bolchazy-Carducci, 1995).

10. Richard Dorf, ed., *The Technology Management Handbook* (CRC Press in conjunction with IEEE Press, 1999).
11. Deborah M. Gordon, "The Regulation of Foraging Activity in Red Harvester Ant Colonies," *The American Naturalist*, Vol. 159, No. 5, May 2002, pp. 509–518, [www.stanford.edu/~dmgordon/gordon2002.pdf](http://www.stanford.edu/~dmgordon/gordon2002.pdf).
12. Eira Hayward, "Game Changing," *Capacity* (April 2011).
13. Nick Wingfield, "Phones Get Game Power in the Cloud," *New York Times*, December 8, 2011. [www.nytimes.com/2011/12/08/technology/phones-and-tablets-getting-game-power-in-the-cloud.html](http://www.nytimes.com/2011/12/08/technology/phones-and-tablets-getting-game-power-in-the-cloud.html).
14. Firas Khatib, "Crystal Structure of a Monomeric Retroviral Protease Solved by Protein Folding Game Players," *Nature*, Structural & Molecular Biology Advance Online Publication, September 18, 2011. [www.cs.washington.edu/homes/zoran/NSMBfoldit-2011.pdf](http://www.cs.washington.edu/homes/zoran/NSMBfoldit-2011.pdf).
15. Henry Chesbrough, *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Harvard Business School Press, 2003).
16. Nicole Laporte, "If These Moms Can't Find It They Invent It," *New York Times*, December 25, 2011. [www.nytimes.com/2011/12/25/business/if-moms-cant-find-it-they-invent-it.html](http://www.nytimes.com/2011/12/25/business/if-moms-cant-find-it-they-invent-it.html).
17. Jan Carlzon, *Moments of Truth* (HarperBusiness, 1989).
18. Rachel Botsman and Roo Rogers, *What's Mine Is Yours: The Rise of Collaborative Consumption* (HarperBusiness, 2010).
19. Derek Gottfrid, "Self-Service, Prorated, Supercomputing Fun," *New York Times*, November 1, 2007. <http://open.blogs.nytimes.com/2007/11/01/self-service-prorated-super-computing-fun/>; David Hilley, "Cloud Computing: A Taxonomy of Platform and Infrastructure-Level Offerings," College of Computing, Georgia Institute of Technology (April 2009).
20. Amazon Web Services, "AWS Case Study: Washington Post." <http://aws.amazon.com/solutions/case-studies/washington-post/>. Accessed April 6th, 2012.
21. Joshua Davis, "Hackers Take Down the Most Wired Country in Europe," *Wired*, August 21, 2007. [www.wired.com/politics/security/magazine/15-09/ff\\_estonia?currentPage=all](http://www.wired.com/politics/security/magazine/15-09/ff_estonia?currentPage=all).
22. United States Department of Defense, "Department of Defense Strategy for Operating in Cyberspace" (July 2011). [www.defense.gov/news/d20110714cyber.pdf](http://www.defense.gov/news/d20110714cyber.pdf).
23. Bill Gertz, "Computer-Based Attacks Emerge as Threat of Future, General Says," *Washington Times*, September 13, 2011. [www.washingtontimes.com/news/2011/sep/13/computer-based-attacks-emerge-as-threat-of-future/](http://www.washingtontimes.com/news/2011/sep/13/computer-based-attacks-emerge-as-threat-of-future/).
24. Robert McMillan, "Was Stuxnet Built to Attack Iran's Nuclear Program?" *PCWorld*, September 21, 2010. [www.pcworld.com/businesscenter/article/205827/was\\_stuxnet\\_built\\_to\\_attack\\_irans\\_nuclear\\_program.html](http://www.pcworld.com/businesscenter/article/205827/was_stuxnet_built_to_attack_irans_nuclear_program.html).
25. William J. Broad and David E. Sanger, "Worm Was Perfect for Sabotaging Centrifuges," *New York Times*, November 18, 2010. [www.nytimes.com/2010/11/19/world/middleeast/19stuxnet.html](http://www.nytimes.com/2010/11/19/world/middleeast/19stuxnet.html).
26. The White House, "International Strategy for Cyberspace: Prosperity, Security, and Openness in a Networked World." [www.whitehouse.gov/sites/default/files/rss\\_viewer/international\\_strategy\\_for\\_cyberspace.pdf](http://www.whitehouse.gov/sites/default/files/rss_viewer/international_strategy_for_cyberspace.pdf). Accessed May, 2011.

27. "MIT Launches Online Learning Initiative," MITnews, December 19, 2011. <http://web.mit.edu/newsoffice/2011/mitx-education-initiative-1219.html>.
28. "Social Media in the 16th Century: How Luther Went Viral," *The Economist*, December 17, 2011. [www.economist.com/node/21541719](http://www.economist.com/node/21541719).
29. Geoffrey A. Fowler, "Amazon Says WikiLeaks Violated Terms of Service," *Wall Street Journal*, December 3, 2010. <http://online.wsj.com/article/SB10001424052748703377504575651321402763304.html>.
30. Randall Lane, "The United Nations Says Broadband Is Basic Human Right," *Forbes*, November 15, 2011. [www.forbes.com/sites/randalllane/2011/11/15/the-united-nations-says-broadband-is-basic-human-right/](http://www.forbes.com/sites/randalllane/2011/11/15/the-united-nations-says-broadband-is-basic-human-right/).
31. Saeed Ahmed, "Fast Internet Access Becomes a Legal Right In Finland," *CNN*, October 15, 2009.
32. Christopher Yoo, conversation with the author, December 30, 2011.
33. <http://bookmooch.com/>.
34. <http://twitter.com/#!/bookmooch/>.
35. <http://snapgoods.com/>. [www.swapstyle.com/](http://www.swapstyle.com/). The Green Samaritan, "Consume Less/Share More = Access Economy: Takeaway from Sustainable Brands '11." <http://thegreensamaritan.com/2011/06/consume-lessshare-more-access-economy-takeaway-from-sustainable-brands-11/>. [www.airbnb.com/](http://www.airbnb.com/).
36. Alorie Gilbert, "Rivals Vie for Siebel's Customer Spoils," *CNET News*, September 27, 2002. [http://news.cnet.com/Rivals-vie-for-Siebels-customer-spoils/2100-1017\\_3-959878.html](http://news.cnet.com/Rivals-vie-for-Siebels-customer-spoils/2100-1017_3-959878.html).
37. "Take a Load Off: The Age of Cloud Computing," *DrugDevelopment-Technology.com*, November 21, 2011. [www.drugdevelopment-technology.com/features/featuretake-a-load-off-the-age-of-cloud-computing/](http://www.drugdevelopment-technology.com/features/featuretake-a-load-off-the-age-of-cloud-computing/).
38. "[Full version] LightRadio News Conference [London, February 7, 2011]." [www.youtube.com/watch?v=m0BDL61dYVQ&feature=relmfu](http://www.youtube.com/watch?v=m0BDL61dYVQ&feature=relmfu).
39. Robert Jensen, "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector," *Quarterly Journal of Economics* 122, no. 3 (2007): 879–924.
40. Daisuke Wakabayashi, "Japanese Farms Look to the 'Cloud,'" *Wall Street Journal*, January 18, 2011. [online.wsj.com/article/SB10001424052748704029704576087910899748444.html](http://online.wsj.com/article/SB10001424052748704029704576087910899748444.html).
41. B. Joseph Pine II and James H. Gilmore, *The Experience Economy: Work Is Theatre and Every Business a Stage* (Harvard Business School Press, 1999).
42. Juliana Rotich, conversation with the author, November 22, 2011.
43. Ashlee Vance, "The Cloud: Battle of the Tech Titans," *Bloomberg Businessweek*, March 3, 2011. [www.businessweek.com/magazine/content/11\\_11/b4219052599182.htm?chan=magazine+channel\\_top+stories](http://www.businessweek.com/magazine/content/11_11/b4219052599182.htm?chan=magazine+channel_top+stories).
44. John Dillon, conversation with the author, January 29, 2012.
45. <http://twitter.com/#!/whitehouse/status/149237000522825729/photo/1/large>.
46. Colleen Curtis, "President Obama: Extending Payroll Tax Cut Is a 'Boost We Need Right Now,'" *The White House Blog*, December 23, 2011. [www.whitehouse.gov/blog/2011/12/23/president-obama-extending-payroll-tax-cut-boost-we-need-right-now](http://www.whitehouse.gov/blog/2011/12/23/president-obama-extending-payroll-tax-cut-boost-we-need-right-now).

47. Carol Huang, "Facebook and Twitter Key to Arab Spring Uprisings: Report," *The National*, June 6, 2011. [www.thenational.ae/news/uae-news/facebook-and-twitter-key-to-arab-spring-uprisings-report](http://www.thenational.ae/news/uae-news/facebook-and-twitter-key-to-arab-spring-uprisings-report).
48. Josh Halliday, "London Riots: How BlackBerry Messenger Played a Key Role," *Guardian*, August 9, 2011. [www.guardian.co.uk/media/2011/aug/08/london-riots-facebook-twitter-blackberry](http://www.guardian.co.uk/media/2011/aug/08/london-riots-facebook-twitter-blackberry).
49. Don Tapscott, conversation with the author, November 9, 2011.