

Cloudonomics: The Business Value of Cloud Computing – A Review

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An increasing number of products and services are moving into “the cloud.”¹ Understanding why this migration is occurring is therefore important not only for the businessperson, but for telecommunications practitioners and policymakers alike. There are many reference books on the market about cloud computing—the question is which resource will be the most useful to the cloud-layman. *Clouconomics: The Business Value of Cloud Computing*² by Joe Weinman stands apart from other books about cloud computing because, rather than purely addressing the technology or architecture of the cloud, it incorporates discussion of quantitative and behavioral economic factors affecting the adoption and usage of cloud computing.³ Weinman brilliantly mixes technology with economics to empirically explore the value proposition of cloud computing and provides a unique and thoughtful contribution to the ongoing cloud discussion.

Weinman first coined the term “clouconomics” in the summer of 2008 to describe the examination of cloud computing from the business, financial, and economic perspective.⁴ Accordingly, in the book, he considers the “core characteristics of the cloud—on demand resources, usage-based charging, resource sharing, geographic dispersion, and the like—and how they map to and drive business—and even societal—value.”⁵ Weinman asserts that the “laws of clouconomics” apply regardless of domain and are not restricted to cloud computing.⁶ As he describes it, the approach taken in the book is “a sort of freakonomics of the cloud.”⁷ *Clouconomics* “doesn’t focus on industry market projections or vendor offerings but rather on strategy, business models, customer value, and their relationships.”⁸

The main premise of the book is that adoption of cloud computing can cut costs and “add value.” Weinman relies primarily on clouconomics to reach this conclusion. The amount of research incorporated into the book

1. “The cloud” is shorthand for “cloud computing.” See *infra* note 2 at 1. Defining “cloud computing” is somewhat controversial. The definition most accepted by industry was created by the National Institute of Standards and Technology (“NIST”): “Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models.” See NAT’L INST. OF STANDARDS AND TECH., NIST SPECIAL PUBLICATION 800-145, THE NIST DEFINITION OF CLOUD COMPUTING (2011) [hereinafter *NIST Definition Document*], available at <http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf>.

2. JOE WEINMAN, *CLOUDONOMICS: THE BUSINESS VALUE OF CLOUD COMPUTING* (2012) [hereinafter *CLOUDONOMICS*].

3. Weinman notes that some differentiate between “cloud services” and “cloud computing,” but these distinctions mean little for the purposes of his book. See *id.* at 13 n.1.

4. *Id.* at xvii.

5. *Id.* at xvii-xviii.

6. *Id.* at xviii.

7. *Id.* at xix.

8. *Id.*

is astonishing; every point made is thoroughly supported with economics, facts, and citations. The book is not necessarily “pro-cloud” and does not attempt to sell or push cloud computing; *Cloudonomics* simply provides information for the reader to take into consideration and to evaluate in deciding what is best for his or her organization. Weinman conscientiously presents different perspectives for the reader to consider and recognizes that there is no one-size-fits-all model.

In the first part of the book, Weinman presents a conceptual view of cloud computing. Weinman starts by examining the relationship between traditional information technology (“IT”) and the cloud. Weinman argues that cloud computing can complement a traditional IT strategy as well as offer value on its own.⁹ Next, Weinman tackles the common assertions made about the cloud and presents examples of what the cloud is and is not.¹⁰ He also addresses the ongoing debate about the correct definition of cloud computing and presents his own definition to provide a foundation for the book.¹¹

The majority of the book is dedicated to applying economic reasoning to multiple aspects of the cloud, in order to explain how cloud computing adoption can generate cost savings and value. Weinman uses cloudonomics to illustrate several assertions: (1) the main benefit of cloud computing is its “on-demand” capability;¹² (2) “acceleration” is free in the cloud and can mitigate latency issues;¹³ and (3) the “available” nature of the cloud makes cloud adoption compelling.¹⁴ Weinman asserts that “cloud computing should be at least part of your overall enterprise IT strategy,”¹⁵ and a “hybrid cloud” strategy is cost optimal.¹⁶

Weinman also applies behavioral economics to analyze the human factors that affect cloud adoption.¹⁷ This discussion adds an important perspective to the conversation and makes the reader think about the social and emotional issues involved in executive decision-making. The book then examines industry patterns, highlighting the telecommunications industry to bolster Weinman’s main argument that the cloud can provide a

9. See generally *id.* at 22-40.

10. See generally *id.* at 49-62.

11. See generally *id.* at 63-76.

12. *Id.* at 207.

13. *Id.* at 274.

14. *Id.* at 301.

15. *Id.* at 169.

16. See generally *id.* at 171-80. Weinman states that hybrid clouds are often visualized as an enterprise data center networked to a cloud service provider, and he identifies variations on this model: for example, “some service providers offer hybrid hosting, a mix of colocation, managed services, and cloud services.” *Id.* at 175. A hybrid cloud is “a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).” *NIST Definition Document*, *supra* note 1, at 3.

17. See generally CLOUDONOMICS, *supra* note 2, at 303-14.

cost reduction mechanism and additional business value.¹⁸ Finally, Weinman uses economic theory to make predictions for the future of the cloud, discussing possible pricing model variations, third-party industry creation, and collaboration with emerging niches such as big data.¹⁹

Clouconomics covers a broad range of topics and is written somewhat sequentially, but the twenty-five chapters are “largely self-contained” so the reader can jump into any chapter of interest.²⁰ There is no specific chapter dedicated to the law; however, potential legal and regulatory considerations are mentioned throughout the book. The overview below groups Weinman’s assertions into the following categories: cloud computing concepts, the economics of cloud computing, behavioral clouconomics, the future of cloud computing, and clouconomics and the law.

I. CLOUD COMPUTING CONCEPTS

Clouconomics begins with a conceptual overview of cloud computing.²¹ Typically, a cloud publication or industry event will begin by attempting to define “cloud computing.” In the introduction to *Clouconomics*, Weinman acknowledges, “what [the cloud] *is*, is a matter of disagreement.”²² He quickly presents his definitional mnemonic for C.L.O.U.D., which involves the important attributes of the technology: **C**ommon infrastructure, **L**ocation independence, **O**nline accessibility, **U**tility pricing and on-**D**emand resources.²³ After providing this foundation, Weinman concentrates on defining his concept of “clouconomics.”²⁴

In the first chapter, Weinman compares the cloud computing business model to the business model of the road network of the Roman Empire.²⁵ Weinman asserts that “[t]he 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.”²⁶ This comparison prepares the reader to bridge traditional economic theory with new or future technologies.

Weinman reinforces the importance of cloud computing by asserting that the cloud is “disrupting every dimension of business”²⁷ as well as “radically reshaping the relationship among governments, the governed,

18. See generally *id.* at 317-28.

19. See generally *id.* at 329-50.

20. *Id.* at 12.

21. See CLOUDONOMICS, *supra* note 2, at 1.

22. *Id.* at xvii (“So the cloud is the new, *new* thing, but what it actually *is*, is a matter of disagreement.”).

23. *Id.* at 11.

24. *Id.* at 11-12.

25. *Id.* at 1-2.

26. *Id.* at 13.

27. *Id.* at 4.

and nongovernmental organizations, [which] impact[s] regional balances of power and global stability.”²⁸ He presents examples of cloud impact across the world, supporting the idea that cloud computing is not just a national phenomenon but also a global one.

A. *Cloud Computing Versus Information Technology*

Weinman goes on to examine information technology (“IT”) and cloud computing in the context of competitive strategy, and takes the time to explore different use cases.²⁹ This discussion is valuable, as most chief information officers (“CIOs”) and IT departments are evaluating the multiple trade-offs between cloud computing and traditional IT. Weinman asks, “Does the [c]loud [m]atter?”³⁰ Weinman explains how IT is strategic and that cloud computing, as a variation of IT, contributes to IT’s strategic value.³¹ He describes the necessity to

assess the marginal value created from *cloud* implementations of IT above and beyond the value from *traditional* implementations of IT and show not just a *correlation* between competitive success and basic IT plus cloud value-add but also *causality*.³²

Weinman concedes that empirical data concerning whether IT generates any return was a challenge to analyze,³³ yet he provides several examples of successful companies that realized the value of IT.³⁴ Weinman concludes that “[i]nformation technology is the embodiment of a firm’s ability to exploit information, and the cloud can offer unique implementations of such technology that otherwise would be difficult, if not impossible.”³⁵

Weinman next examines if there is a strategic value of the cloud in and of itself.³⁶ He recognizes that the term “cloud” seems to be overused and that this “cloudwashing” has generated backlash and understandably a sense of caution for CIOs.³⁷ Weinman argues that “[c]loud may well be overhyped, but it is demonstrably creating value.”³⁸ Weinman goes on to discuss the competitive advantages cloud computing can provide, and

28. *Id.*

29. *Id.* at 23-26.

30. *See generally id.* at chs. 2, 17.

31. *Id.* at 17-18.

32. *Id.* at 18.

33. *Id.* at 19.

34. *Id.* at 23-24 (discussing companies, including Inditex, AMR, Goldcorp, Harrah’s, Google and Facebook).

35. *Id.* at 26.

36. *Id.*; *see generally id.* at 29.

37. *Id.* at 29.

38. *Id.* at 30.

concludes that the cloud variation of IT can be technical and tactical, as well as strategic.³⁹ He provides scenarios where the cloud enables companies to go beyond what would be achievable with traditional IT alone by allowing companies to eliminate barriers to scale, leverage network effects, and achieve global brand recognition. Weinman also explains how the cloud provides an even playing field for start-up companies.⁴⁰ As far as aligning cloud computing with business strategy, Weinman states that “[d]ifferent firms will find different opportunities to leverage the cloud.”⁴¹

B. Mythbusting

After establishing that IT and the cloud computing extension of IT can be both valuable and strategic, Weinman reviews the conventional wisdom about cloud computing.⁴² An entire chapter is dedicated to common assertions made about cloud computing, which may be particularly helpful to CIOs and other executives struggling with the idea of cloud adoption. Weinman tackles a list of fourteen common contentions and shows how each are debatable by presenting counterarguments. Overall, the author asserts that the “traditional narrative is appealing but not necessarily correct,”⁴³ and allows room for the reader to make the appropriate conclusions about cloud computing adoption and utilization for his or her unique situation.

C. Defining the Cloud

At the start of Chapter 5, Weinman acknowledges that “[w]e’ve been talking about the cloud without explicitly describing what we mean”⁴⁴ and finally elaborates on defining “the cloud.” This structural feature of the book might frustrate readers new to cloud computing; however, it forces the audience to focus strictly on the economics rather than the technological aspects of the cloud.⁴⁵ The author first presents the most industry-accepted definition crafted by the National Institute of Standards and Technology (“NIST”):

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of

39. *Id.* at 35.

40. *Id.* at 38.

41. *Id.* at 42.

42. *Id.* at 12; *see also id.* at 49.

43. *Id.* at 61.

44. *Id.* at 63.

45. As a seasoned reader on cloud computing, the Reviewer did not find this organization to be troublesome. However, the novice cloud computing reader should start with Chapter 5 first to avoid any foundational frustrations.

configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.⁴⁶

Weinman asserts that his mnemonic definition, C.L.O.U.D. (Common infrastructure, Location independence, Online accessibility, Utility pricing, and on-Demand resources),⁴⁷ is semantically equivalent to the NIST definition⁴⁸ and examines each attribute in greater detail. Chapter 5 also provides examples of what cloud computing is and is not. Weinman asserts that “the cloud concept is related to and draws from other models of computing. However, it can be distinguished from them using the five C.L.O.U.D. criteria.”⁴⁹ Weinman claims that his definition is “domain independent” and can be applied to “taxi services, hotel chains, electric utilities[,] and others.”⁵⁰ Therefore, “much of the analysis in the rest of the book applies not only to cloud *computing* but to these other domains as well.”⁵¹ Weinman’s definition is helpful overall because the mnemonic allows readers to focus on individual words without getting wrapped up in syntax.

The majority of *Cloudonomics* focuses heavily on the Infrastructure-as-a-Service (“IaaS”) layer of the cloud⁵² and discusses the technology at a conceptually high-level. It is not until Chapter 21⁵³ that Weinman finally discusses the other two service layers of cloud architecture: Platform-as-a-Service (“PaaS”)⁵⁴ and Software-as-a-Service (“SaaS”).⁵⁵ To differentiate

46. *Id.* at 65; see generally *NIST Cloud Definition Document*, *supra* note 1.

47. See *CLOUDONOMICS*, *supra* note 2, at 65.

48. *Id.*

49. *Id.* at 75.

50. *Id.* at 76.

51. *Id.*

52. IaaS is “[t]he capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).” *NIST Definition Document*, *supra* note 1, at 3.

53. See generally *CLOUDONOMICS*, *supra* note 2, at ch. 21.

54. PaaS is “[t]he capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.” *NIST Definition Document*, *supra* note 1, at 2-3 (citations omitted).

55. SaaS is “[t]he capability provided to the consumer is to use the provider’s applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying

these three service layers of cloud computing, Weinman explains, “IaaS offers are targeted at operations personnel: those whose job it is to *run* things; PaaS offers are targeted at developers: those who *build* things; and SaaS is targeted at end users: those who *use* things.”⁵⁶ Weinman explains that the benefits and value of PaaS and SaaS resemble IaaS, but also illustrates how PaaS and SaaS “offer additional value in many dimensions.”⁵⁷ This particular chapter provides a useful examination of the potential value of PaaS, SaaS, and the economic issues related to their business models.⁵⁸ Overall, *Clouonomics*’ main focus is on the general concept of cloud computing and does not strictly focus on the three service levels; rather, the service levels are only discussed when appropriate.

II. THE ECONOMICS OF CLOUD COMPUTING

Throughout the book several elaborate economic equations are presented that could easily deter a reader that has little or no mathematical background.⁵⁹ One interesting feature of the book, however, is that it explains clouonomics by using economic formulas, as well as common examples that the reader can understand outside of the cloud computing domain (such as taxis, hotels, and utilities). Weinman seems to instinctually retreat from the equations at the moment the reader would appear to become frustrated. He also pulls in anecdotes and information provided by various “clouderati,”⁶⁰ which provide helpful illustrations of the practical application of his theories.

The book dives deeper into the practical application of cloud computing in Chapter 6. First, Weinman talks about the strategy and value

cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.” *Id.* at 2 (citations omitted).

56. *CLOUDONOMICS*, *supra* note 2, at 277.

57. *Id.* at 290.

58. *See generally id.* at ch. 21. Again, this book is not an introduction to cloud computing and may be geared toward an audience already exposed to the basics. This portion provides just enough information to round out the discussion. A novice to cloud computing may want to seek additional resources to really understand the technical aspects of the different layers of cloud.

59. *See, e.g., id.* at 198-99. The Reviewer does not have an economics background and was unable to verify if the economic equations presented were correct. However, the Reviewer was able to follow the logic of the equations and was able to connect them to the point the author was trying to make.

60. The “clouderati” is an invitation-only group of cloud computing subject matter experts; the list of members is managed on Twitter via the “@clouderati” account. Joe Weinman (as @joeweinman) is a member of this group, and he thanks all of the members of the clouderati at the time of the book’s publication in the introduction. *See id.* at xxiv. The Reviewer, Deborah J. Salons (as @dsalons), is also a member of the clouderati, but was not invited to the group until after the publication of *Clouonomics* and was not nominated by Weinman or personally acknowledged by Weinman in *Clouonomics*.

of cloud computing related to cost reduction and business agility,⁶¹ while incorporating economic concepts such as unit cost, delivered cost, and opportunity cost.⁶² Weinman asserts that the cloud is a “service business” and discusses the total solution cost, which would be helpful to CIOs, CTOs, and CFOs.⁶³ He also explores the value of customer and user experience, employee satisfaction, and risk.⁶⁴ Weinman concludes that the cloud “generates values in many ways” and “can support a broad range of financial, strategic, employee, and customer goals.”⁶⁵

Just as the reader is left with a very pro-cloud impression, Chapter 7 discusses when it is or is not appropriate for an organization to adopt the cloud.⁶⁶ Weinman states honestly that “it depends is often the correct answer” to whether or not to use the cloud.⁶⁷ “Different companies with different strategies at different times may have different perspectives on where and why to use the cloud.”⁶⁸ The author then explores use cases⁶⁹ supporting cloud, including, but not limited to, capabilities, communications, community, collections, and consolidations.⁷⁰ Weinman also provides inappropriate cloud use cases, including, but not limited to, constant, custom, compression, and caching.⁷¹ Overall, Weinman sets forth both positive and negative cloud computing use cases. He is not simply pushing cloud adoption; he is forcing the reader to take a look at a variety of considerations.⁷²

Weinman applies economic theory to common IT problems, such as demand dilemmas,⁷³ capacity conundrums,⁷⁴ and significance of scale,⁷⁵ explaining how a cloud computing strategy provides a viable solution to those problems. First, he discusses how variable and unpredictable demand is problematic when applied to IT strategies.⁷⁶ Next, Weinman shows how deploying capacity to respond to variable and unpredictable demand also poses a challenge to cost.⁷⁷ He uses quantitative economic analysis to show there will “not be a perfect solution that minimizes the total cost, without

61. *See generally id.* at ch. 6.

62. *See id.* at 80-83.

63. *Id.* at 81-82.

64. *See id.* at 86-88.

65. *Id.* at 89.

66. *Id.* at 91.

67. *Id.*

68. *Id.*

69. *Id.* (explaining that “use cases” are scenarios).

70. *Id.* at 91-100.

71. *Id.* at 101-03.

72. *See id.* at 101 (“There is much promise and value in the cloud, but that doesn’t mean it’s appropriate for all applications.”).

73. *Id.* at 107.

74. *Id.* at 125.

75. *Id.* at 137.

76. *Id.* at 111-18.

77. *Id.* at 135.

relying on the on-demand, pay-per-use nature of the cloud.”⁷⁸ The concept of economies of scale is also examined to explore the possible cost advantages of cloud computing relative to do-it-yourself approaches.⁷⁹

Weinman fortifies the benefits of cloud computing solutions by asserting that “even if the cloud is more expensive on a unit-cost basis, the cloud still can cost less, in terms of total cost.”⁸⁰ He presents an economic analysis to conclude that more is less. He shows that “even if cloud computing is more expensive (on a unit-cost basis), you can still use it and save money.”⁸¹ Weinman asserts that “[i]f you take nothing else away from this book, it’s that cloud computing should be at least part of your overall enterprise IT strategy.”⁸² This cost analysis is the root of Weinman’s argument that hybrid clouds are likely to be cost optimal.⁸³ Again, the author shows how there is a benefit to cloud computing and recognizes there is no perfect solution and no one-size-fits-all IT strategy. Weinman only gives the reader the tools to perform an analysis for his or her specific situation.

A. On-Demand Properties of Cloud Computing

The on-demand property of the cloud is the focus of the next portion of the book. Weinman dedicates an entire chapter to explaining that forecasting is fallible,⁸⁴ especially in IT where uncertainty can result from a range of factors such as sudden customer demand spikes, data center outages due to severe weather, distributed denial of service attacks, as well as human error or malice.⁸⁵ Weinman solves this dilemma by arguing that “rather than attempting to forecast, it’s easier to exploit the benefits of on-demand capacity.”⁸⁶ Weinman uses economic formulas and theory to assert that “[a] true cloud . . . can achieve real business value by minimizing the penalty cost of the wrong capacity to zero.”⁸⁷ Although the economic theory is very heavy in this explanation, Weinman still accompanies the formulas with real-life illustrations (in this case, a tennis match) to help the reader move along.⁸⁸ This all supports his main point: “Using on-demand capacity—that is, elasticity—to meet unpredictable, accelerated growth is

78. *Id.*; *see id.* at 125-34.

79. *Id.* at 137-55; *see id.* at 147-49 (list of cost factors to consider when choosing between a cloud or do-it-yourself IT strategy).

80. *Id.* at 159.

81. *Id.* at 161-69.

82. *Id.* at 169.

83. *Id.* at 174. *See id.* at 171-80 (explaining and illustrating hybrid architecture options). *See also id.* at 303-14 (hybrid cloud definition).

84. *Id.* at 181-82.

85. *Id.* at 187.

86. *Id.* at 207.

87. *Id.*

88. *Id.* at 198-99.

one of the main benefits of the cloud”⁸⁹ The book then expands upon the on-demand property of the cloud and addresses how to achieve peak performance while dealing with variable demands.⁹⁰ Statistical and mathematical equations explain that aggregating variable demands will work “as long as demands aren’t correlated and don’t have simultaneous peaks.”⁹¹

B. Latency Issues in the Cloud

Five chapters of the book are dedicated to discussing the value of time and the issue of latency in the cloud.⁹² Latency issues involve the “delays due to signal transmission time over distance.”⁹³ Weinman explains that “[f]or waiting customers . . . the perception of time is different from the actual passage of time,”⁹⁴ and signifies the “race to zero”—the escalating competition “to get as close as possible to the shortest possible time.”⁹⁵ For service providers and enterprise, “[l]ocating facilities close to optimized network routes to key services is an essential strategy.”⁹⁶

Weinman again applies economics to explore strategies to improve response time in the cloud. He takes a closer look at the benefits of parallel processing⁹⁷ to assert that acceleration in the cloud is free because “[r]egardless of the number of processors, the cost remains constant.”⁹⁸ Weinman also examines possible latency shortcuts⁹⁹ and concludes that even with increased bandwidth, latency will always remain an issue.¹⁰⁰ Assuming that “latency is proportional to distance,”¹⁰¹ Weinman examines the solution of a distributed architecture and concludes that “the pay-per-use model of the cloud enables customers to enjoy latency reduction for free by exploiting dispersion.”¹⁰² Finally, the author evaluates consolidation

89. *Id.* at 207.

90. *Id.* at 209-25.

91. *Id.* at 225.

92. *See id.* at chs. 16-20.

93. *Id.* at 245.

94. *Id.* at 229 (emphasis removed).

95. *Id.* at 227.

96. *Id.* at 228.

97. *See generally id.* at 235-43. Parallel processing is “a mode of operation in which a process is split into parts, which are executed simultaneously on different processors attached to the same computer.” *See Parallel Processing Definition*, OXFORDDICTIONARY.COM, <http://oxforddictionaries.com/definition/english/parallel%2Bprocessing?q=parallel+processing> (last visited May 16, 2013).

98. *See* CLOUDONOMICS, *supra* note 2, at 241.

99. *Id.* at 245-53.

100. *Id.* at 252-53 (citing OFFICE OF ENG’G & TECH. & CONSUMER & GOVERNMENTAL AFFAIRS BUREAU, FCC, MEASURING BROADBAND AMERICA: A REPORT ON CONSUMER WIRELINE BROADBAND PERFORMANCE IN THE U.S. (2011), *available at* <https://www.fcc.gov/measuring-broadband-america>).

101. CLOUDONOMICS, *supra* note 2, at 257.

102. *Id.* at 263.

and dispersion strategies and concludes that consolidation and processing strategy can be weaved together for balance.¹⁰³ Weinman's bottom line is that with the cloud it is all less costly.¹⁰⁴ These strategies "offe[r] free acceleration through pay-per-use parallel processing and, in some cases, free dispersion via partitionable resources."¹⁰⁵

C. Availability

Weinman wraps up the economic discussion of the different cloud computing attributes with a chapter on availability, which he refers to as "a complex mixture of components, including architecture, process, partner selection, and technology diversity."¹⁰⁶ Using cloudonomics, the author illustrates how redundancy can enhance availability¹⁰⁷: "In addition to redundancy *within* a data center or across multiple data centers in the cloud, there can be redundancy *between* an enterprise data center and the cloud."¹⁰⁸ Putting it all together, Weinman states: "Various attributes of the cloud, such as geographical dispersion and on-demand, pay-per-use resources, make the economics of cloud availability compelling."¹⁰⁹

III. BEHAVIORAL CLOUDONOMICS

Near the end of the book, Weinman switches focus from quantitative economic analysis to behavioral economic analysis, recognizing that rational thinking often collides with human emotional, intuitive, and irrational behaviors.¹¹⁰ Weinman advises that "[p]rospects considering cloud services should become aware of their own biases and incorporate that knowledge in their decision-making processes,"¹¹¹ while "[s]ervice providers marketing to those prospects or existing customers should be aware that there is more to decision making than return-on-investment calculations."¹¹² Weinman emphasizes that regardless of the existence of

103. *Id.* at 265-74.

104. *Id.*

105. *Id.* at 274.

106. *Id.* at 301.

107. *See id.* at 297-301 (stating that the redundancy of components in the structure of the cloud enables the cloud service to continue to function even when individual components, such as servers, inevitably malfunction).

108. *Id.* at 300.

109. *Id.* at 301.

110. *See id.* at 303-13 (commenting that the biases created by the fact that we are not solely rational decision makers contributes to certain dispositions in connection with cloud adoption; also discussing psychological phenomena such as loss and risk aversion, flat-rate bias, framing and context, the need for control and autonomy, fear of change, hearing and conformity, the endowment effect, the need for status, paralysis by analysis of choice, hyperbolic discounts and instant gratification, and the zero-price effect).

111. *Id.* at 313.

112. *Id.*

logic and rational thinking, the human element cannot be ignored and provides valuable perspective that makes the analysis found in *Clouddonomics* well rounded. This chapter serves as a good resource during decision-making situations.

The penultimate chapter of the book focuses on “cloud patterns” and “illustrates that cloud-native applications can be evaluated using a variety of mechanisms.”¹¹³ Weinman explores communications patterns by focusing on the “the first cloud service of the modern era—the telephone exchange.”¹¹⁴ Mixing economics with various communications architectures, including subsea cables, microwave towers, and broadcast, is the tactic used to explore the costs and values of networks.¹¹⁵ Weinman then discusses markets, stating that “[r]ather than all endpoints communicating with each other, a cloud-based marketplace can be divided into buyers and sellers that interact only between groups, not within.”¹¹⁶ He also notes how the cloud can act as a “repository”¹¹⁷ and establish a perimeter around networks.¹¹⁸ Weinman’s purpose in exploring the variety of patterns is to point out that cloud computing not only provides a cost reduction mechanism but also adds value.¹¹⁹ Overall, this chapter is very heavy on economics but will be of particular interest to telecommunications attorneys because of the focus on traditional communication structures.

IV. THE FUTURE OF CLOUD COMPUTING

Finally, Weinman closes the book with predicting the future of cloud computing. Some of his predictions involve the following: pricing,¹²⁰ the role of third-party intermediaries such as cloud service brokers,¹²¹ the development of a network of clouds or the “Intercloud,”¹²² a variety of cloud federations and alliances,¹²³ and possible industry consolidation and concentration.¹²⁴ Weinman also mentions extensions of cloud computing that are considered leading industry topics, such as big data,¹²⁵ storage,¹²⁶

113. *Id.* at 317.

114. *Id.* at 318.

115. *Id.* at 321.

116. *Id.* at 323.

117. *Id.* at 326.

118. *Id.* at 326-27.

119. *Id.* at 327.

120. *Id.* at 329-32.

121. *Id.* at 333.

122. *Id.* at 334-35.

123. *Id.* at 335.

124. *Id.* at 336.

125. *Id.* at 339.

126. *Id.* at 343.

standards, application programming interfaces (“APIs”), and rating agencies.¹²⁷

Weinman ultimately concludes that “[t]he chaotic, stochastic, complex adaptive characteristics of the industry and its ambient environment suggest that we are still at the beginning of a Cambrian explosion in information technologies generally and in the cloud in particular.”¹²⁸ At the rate of innovation, and the daily discoveries made in cloud technology, there is no concrete roadmap for the future of the cloud. Understanding the concepts addressed in *Clouconomics* can assist with whatever the future may hold.

V. CLOUDONOMICS AND THE LAW

Clouconomics does not specifically focus on the law, but legal and regulatory considerations do not go unaddressed. A telecommunications practitioner can appreciate this book as Weinman acknowledges that communications make the cloud possible, and he uses past and present examples of applicable telecommunications use studies. For example, the history of telephony, undersea cables, mobile telephones, spectrum auctions, and FCC research¹²⁹ are all brought into the clouconomics analysis. This is unique for a book on cloud computing because other texts typically focus on the hi-tech aspects and architecture of the technology and do not recognize the critical communications foundation necessary for the technology to work.

In the first chapter, Weinman recognizes that “the rapid emergence of the cloud is rapidly outpacing a legal and regulatory system designed for an earlier age”¹³⁰ and that “[t]he cloud is impacting and challenging privacy, regulation, and law.”¹³¹ This is often the frustration for many attorneys trying to counsel clients either providing or implementing cloud computing. *Clouconomics* provides useful information and discussion for practitioners trying to understand or anticipate how business, technology and regulation will converge or clash in the future. The book also takes time to focus on Cloud Service Provider (“CSP”) Clouconomics and to examine the economic value of Service Level Agreements (“SLAs”).¹³² The discussion brings up the risk levels that both the CSP and customer are willing to take when entering into SLAs and how the penalties for SLA violations may be calculated into the CSP business model.¹³³ The CSP

127. *Id.* at 344-45.

128. *Id.* at 349.

129. *See id.* at 253.

130. *Id.* at 6.

131. *Id.*

132. *See id.* at 210-12.

133. *See id.* at 212, 222.

perspective is revisited throughout the book and provides useful information for attorneys representing cloud providers.

At the close of the book, one of Weinman's cloud computing predictions involves a legal component: "Cloud services are at the eye of a perfect storm of demand-side diversity, regulation, and continued customer preference for local presence."¹³⁴ Regulation of the cloud is a topic often pondered in the cloud computing community; however, the creation of regulation is slower than the speed of innovation. Other instances of legal predictions include the necessity for SLA clarity or reform¹³⁵ and the possibility of antitrust regulations in the instance of consolidation.¹³⁶

VI. CONCLUSION

Cloudonomics is a "must read" for any businessperson, telecommunications practitioner, or policymaker involved with cloud computing. Enterprise professionals can use all of this information to develop a cloud computing strategy, balance IT with the cloud, and pick a CSP or several CSPs. CSPs can use this information to understand their own business components as well as their customer concerns. Every organization will be different, but as Weinman suggests, cloudonomics is applicable to many diverse sectors and can be a helpful tool in making management and business decisions.

This book is a comprehensive resource on the business value of cloud computing. Every assertion is supported with economic theory or fact, and the book cites multiple useful references at the end of each chapter. There are also helpful graphics and illustrations of the concepts that assist the reader throughout the book. *Cloudonomics* does more than provide a primer on cloud computing; it dives deep into economic analysis and addresses common sense business concerns.¹³⁷

As Weinman states in the first chapter, "[t]he most exciting thing about the cloud is in how it can create value and transform traditional economic assumptions."¹³⁸ This book can be used to understand the cloud and examine ways it can save costs and add value to business. "The future of cloud is sunny indeed,"¹³⁹ and *Cloudonomics* is a valuable resource for understanding cloud computing and making informed decisions regarding where the cloud fits in any business strategy.

134. *Id.* at 338.

135. *Id.* at 333-34.

136. *Id.* at 337.

137. *Cloudonomics* also offers complementary online resources as an added bonus, such as the Cloudonomics website and the online references featured at the end of the chapters. Websites include Cloudonomics.com, ComplexModels.com and <http://joeweinman.com/papers.htm>.

138. *Id.* at 13.

139. *Id.* at 349.