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Cloud Migration

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Brett McLaughlin

About Virtana

Virtana is the leading hybrid cloud optimization platform for digital transformation. Its technology and services give innovative organizations the clarity they need to take control of their infrastructure; plan, transform, and optimize their cloud operations; and deliver a superior brand experience. Virtana's software modernizes IT, supporting its agility while guaranteeing performance, minimizing risk, and reducing cost. We guide users on a journey to see their infrastructure from a single pane of glass, act on issues that arise, and transform processes for future automation.

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Publisher's Acknowledgments

Introduction

"To the cloud!" That was the tagline of a famous commercial a few years back, and while the sentiment was perhaps overly simple, the intent was right on the money. Everyone is moving to the cloud these days, and for good reason.

The era of giant servers running in frigid rooms, raised flooring for miles of network cabling, "spinning disks" overheating and needing to be replaced, server blades and memory sticks, well, that era is coming to an end for almost every company in the world. That era was costly, was resource- and maintenance-intensive, and required a massive personnel commitment to be sustained.

The new era — that of the cloud — is still complex and requires tremendous expertise. But unparalleled increases in bandwidth, disk capacity, computational power, and architectural flexibility are all available, often at fractions of the pricing found in the on-premises era. Applications have greater demands on a wider array of services than ever before, and the cloud can be the best way to make these applications sustainable, cost-effective, and flexible.

But the reality is that "to the cloud" really is just a tagline, a clever marketing phrase. Actually moving to the cloud is as complex as the cloud itself, and it often requires radical upheaval before success. It's a tricky process, requiring the right people, clear goals, and, in almost every case, an experienced and savvy partner. But by bringing to bear the right resources with the right expectations, you can reduce the complexity of a migration and get to the significant benefits of the cloud much more quickly.

In *Cloud Migration For Dummies,* I outline the different options you have to migrate your own infrastructure and applications to the cloud, including best practices, tips that come from the experience of multiple actual migrations, and how to ensure success after you're on the cloud.

About This Book

This is a book about migrating to the cloud. It's direct, clear, and instructional. It stands on its own, and while you'll certainly need many more resources to complete a successful cloud migration, this book can easily serve as your high-level guide, stuck in a back pocket or pulled up with a few touches on your tablet.

Because this book is meant to be small and direct, it doesn't mince words, and topics that might span eight pages may only show up as a bulleted list in this book. However, the upside is you can easily read it over a lunch break, and then refer back to it as much as you need.

You should consider this book as a jumping-off point. Each chapter, and even each section, should cause you to generate questions and notes that will lead you into potentially deeper exploration of the topic at hand. Follow those questions and interests, and then come back to the next chapter, the next section. By the time you're finished, you'll have a clear picture of a good cloud migration and how to architect and manage your own.

Foolish Assumptions

You may have heard what assuming does to you and me, but despite the old warning, I still make a few assumptions in this book:

» **I assume that you want to perform a cloud migration (or maybe more than one), and you're trying to figure out how best to make that successful.** I do *not* spend any substantial time laying out the advantages of the cloud, or how to decide if you may want to migrate. That would take more space than I have in a book of this length.

» **I assume you have a basic understanding of the cloud.** If you're an IT executive, a chief technology officer (CTO), or a chief information officer (CIO), this book will give you a simple organized framework for preparing a cloud migration.

> This book isn't just for executives, though. IT managers, engineering vice presidents, and technologists will find a clear blueprint and keys to successfully moving your applications and technologies into the cloud. This book doesn't have a ton of code, but it's very much a technically driven book. You'll find security and sizing considerations are addressed, as well as recommendations for taking advantage of what the cloud has to offer.

If any of these assumptions and assertions describe and appeal to you, then this is your book. If none of them do, keep reading anyway — you'll learn a ton about the cloud and you may find yourself intrigued and wanting to learn more.

How This Book is Organized

Cloud Migration For Dummies consists of seven chapters that explore the following:

>> The basics of a cloud computing environment, and common terms you'll want to get familiar with (Chapter 1)

>> Preparing for a cloud migration, from the roles and people involved to the meetings you'll need (Chapter 2)

>> Understanding your options for cloud migration and making a good decision about which option to choose (Chapter 3)

>> How to test out your migration before you go live (Chapter 4)

>> Flipping the switch on your migration (Chapter 5)

>> Building out systems to ensure your system *stays* running in the cloud (Chapter 6)

>> Ten ways to guarantee a successful cloud migration (Chapter 7)

Each chapter is written to stand more or less on its own, so if you see a topic that interests you, feel free to jump ahead to that chapter. If topics are mentioned in one chapter but covered in more detail in another chapter, I let you know.

That said, each chapter does create a progressively detailed picture of a successful cloud migration, from the first to the last. If you're new to this topic, or you're about to take on a cloud migration in your company, you'll get the most value from reading this book front to back. That's why I've kept it short and direct!

Icons Used in This Book

Throughout the book, I occasionally use special icons to call attention to important information. Here's what to expect:

REMEMBER This icon points out important information you should commit to your nonvolatile memory, your gray matter, or your noggin — along with anniversaries and birthdays!

TIP Tips are appreciated, never expected, and I sure hope you'll appreciate those useful nuggets of information.

WARNING These alerts point out the stuff your mother warned you about. Well, probably not, but they do offer practical advice to help you avoid potentially costly or frustrating mistakes.

Where to Go From Here

There's only so much I can cover in 48 short pages, so if you find yourself at the end of this book, thinking, "Gosh, this was an amazing book! Where can I learn more?," check out www.virtana.com/products/cloud-migration-readiness.

Chapter **1**
Cloud Computing Environments 101

In this chapter, I explain the ins and outs of cloud terminology. That will prepare you to get into how to compare your on-premises environments with cloud-based ones. I also explain how responsibility in the cloud is very different from what you're probably used to.

Learning Cloud Terminology

There's definitely a lingo when it comes to the cloud. You don't need to know every term — and Google is always your friend — but there are some key terms you *should* know. That's what I cover in this section.

Everything begins with a cloud provider

Choosing a cloud provider — like Amazon Web Services (AWS), Google Cloud Platform (GCP), or Microsoft Azure — is likely the first decision you'll make. The provider gives you the resources you'll use for your own cloud environment.

Cloud providers have a few key capabilities:

>> **Virtualization:** Virtualization takes actual resources and provides a different view of those resources to you. Most of the resources in the cloud are virtual; they don't directly map to real pieces of hardware.

>> **Managed service:** A managed service is a capability that the cloud provider manages (so you don't have to).

>> **Environment:** Cloud providers let you create multiple environments, either within a single account or across accounts. Environments are completely independent and can represent different pieces of applications, or separate development from testing from production.

As-a abbreviations

The cloud, like most technologies, is full of abbreviated terms. Here are three that relate to how you plan on using the cloud:

>> **Infrastructure as a service (IaaS):** This is the most basic way to use the cloud. You're taking the file storage and network connections and computational units of the cloud provider and building them up into your system.

>> **Platform as a service (PaaS):** In PaaS, you're using not just the raw resources of a cloud provider, but the more advanced features and services that the provider offers. So, you may use a managed database service or a serverless code runner.

THE VALUE OF A MANAGED SERVICE

Managed services are one of the biggest advantages of the cloud. A managed service takes something that usually is your responsibility to staff and deal with — like a database — and takes a large amount of that responsibility off your shoulders. In general, the more you can use managed services, the more value you'll gain from a cloud migration.

>> **Software as a service (SaaS):** Here, software from a vendor gives you functionality and takes care of cloud hosting for you. So, you may use an e-commerce SaaS, for example.

Understanding What's Different about the Cloud

Even more than terminology, the biggest favor you can do yourself is to move away from thinking the cloud is just a virtual closet in the sky.

Yes, you can migrate your current servers and networks and databases directly into the cloud. There's even a name for that: It's called *lift and shift,* and it's discussed in Chapter 3. But if you really want to maximize value in your cloud migration, you'll consider going well beyond just moving your existing resources and applications as is.

The cloud values independent application components

One big advantage of the cloud is its ability to scale in and scale out. Almost anything you put in the cloud is capable of scaling out to meet demand and scaling in to reduce cost. But that sort of scaling requires anything you put in the cloud to be independent of other components. If you have a web server that assumes it's got the only database connection, that web server can't scale out, because then you'll have two web servers, both acting as if they're the only one. The same is true of your application programming interfaces (APIs), databases, and integrations.

The more independent your components, the better they'll scale in and out, and the more optimized your environment will be.

The cloud is widely distributed

You probably already realize that the cloud isn't just one set of servers in one place. You won't have to worry about that too much, but you still need to think about the general location of your environments and resources.

SCALING IN THE CLOUD IS HORIZONTAL

You're probably used to thinking about an application scaling *up* to meet demand and then back *down* when demand decreases. Think of this as the equivalent to moving your application to a bigger server in your data center with more CPU, memory, and networking when you need it. In the cloud, although this is still possible to some extent (for instance, by adding more resources to a cloud-based virtual machine), the best outcomes result when your application is architected to scale *out* or *in.* Think of a horizontal row of virtual servers. If more servers are needed, the row grows wider — that's called *scaling out.* If fewer servers are needed, the row gets narrower — that's called *scaling in.* The classic model for this is the three tier web application — using web servers, application servers, and databases. Load grows fastest on the web server tier, and more can be added or removed when needed. In contrast, the application server tier may occasionally need to add or remove a server and the data tier is static.

Cloud providers typically support the following:

>> **Regions:** A region is a large geographical area, often with multiple zones. So, you may have the eastern region of the United States or the southern region of Japan.

>> **Zones:** A zone is a smaller area of service. Most zones also have redundancy, often two or three actual data centers that support your virtualized cloud environments.

You use multiple regions to support better fault tolerance and disaster recovery. You can also use different regions to serve customers closer to their actual location. A customer in Japan will see much better performance from an application hosted in that area than one hosted in a region of the United States will.

The cloud is flexible

You can have a near-infinite number of configurations in the cloud. You can store your data on your local network but put web servers in the cloud. You can host all your infrastructure in the cloud. You can ditch your infrastructure altogether and write code

that never requires a virtual server. And you can combine all these into a never-before-seen configuration perfect for your needs.

Sharing Responsibility for Operation

One final significant change when migrating to the cloud is the sharing of control. You no longer wholly own your servers, your network, or your database. But you *also* no longer wholly own the upkeep, patching, and versioning of those resources. You *jointly* own both of these with your cloud provider.

This is called a *shared responsibility model.* You have responsibility for your data, your application security, and how you use the cloud resources you employ. But your cloud provider has responsibility for the security of those resources and keeping them running at a basic level. For more on cloud security and the shared responsibility model, check out the Cloud Security Alliance (`https://cloudsecurityalliance.org`).

Chapter **2**

Preparing for a Cloud Migration

There's no substitute for a good plan — every smooth cloud migration began with a great plan. You need to have clear goals, well-staffed and communicating teams, and in most cases, help from a partner that has done multiple cloud migrations. Add those factors up, and you'll have a much stronger and more efficient cloud migration.

Setting Clear Goals and Expectations for Return on Investment

Return on investment (ROI) is a business term that's thrown around a lot. With a cloud migration, tying the ROI to the overall digital transformation strategy is essential. You're migrating to get something. Whether you want to reduce costs, take advantage of new capabilities, enable scaling on demand, or take advantage of cloud infrastructure to more quickly respond to changes in business environment, you're looking for a return on your migration investment. That return begins with understanding your "now."

A helpful way to quantify expectations is to examine the following:

>> What you want to reduce

>> What you want to increase

>> What's not working

What do you want to reduce?

Begin with things you want to reduce. These are usually pretty easy and often fall into one of these categories:

>> **Cost:** Everybody wants to pay less, and the cloud is exceptional (when a migration is done well) at reducing overall spend.

>> **Wasted resources:** Over-provisioning is when you have more compute power, disk space, bandwidth, or anything else that is sitting idle. A migration can help right-size your resources.

>> **Time spent not getting important things done:** "Get important things done" sounds vague, but it's still true. The more time your staff is configuring networks or troubleshooting servers, the less time is available to move the business forward with innovative applications.

PEOPLE ARE RESOURCES

It's easy to think about a server sitting idle as a wasted resource. But you also can have staff that are wasted as well. Sometimes you have a specialist — perhaps a database administrator — who is paid full-time to work on tasks that take 20 hours a week. Those are wasted hours and, therefore, wasted resources.

If you can significantly reduce redundant tasks like upkeep and maintenance, you can remove those wasted resources. Repurpose them to higher-value tasks or replace them with business-specific needs.

What do you want to increase?

In addition to reduced costs and waste, you should see increases in important activities. Even if those improvements are just the result of reductions, make a note of them as goals for your project, and record them.

Common goals for improvement include the following:

» **Flexibility:** A cloud environment is inherently more flexible than an on-premises one. You can turn off five database servers and turn on four file stores in minutes, with no capital cost and minimal configuration.

» **Customer engagement:** With the time and money available for a reduction in overhead and maintenance, you can build more dynamic customer experiences. You can also take advantage of greater performance, resulting in customer satisfaction.

» **Business analytics:** The cloud offers access to advanced analytics tools, as well as machine learning often inaccessible to even medium-size businesses at a fraction of the cost.

» **Online offerings:** If you have a significant physical presence, a cloud migration can enable you to move many of your products to a digital delivery model and increase their visibility and sales.

What's not working?

With a clear understanding of what you want more of and what you want less of, turn your attention to what could be improved through a cloud migration.

This is harder to quantify because each business is unique, but a common improvement is the ratio between your capital expenditures (CapEx) and your operational expenditures (OpEx). CapEx will be high for on-premises installations. You pay a lot upfront for equipment, and you pay a lot in recurring chunks to replace that equipment. OpEx is what you "pay as you go." Many businesses prefer to reduce CapEx in favor of OpEx. A cloud migration is a great way to make that adjustment — to make your CapEx work better for you.

Another common improvement from cloud migration is a technical staff that is engaged and modern in development and operations practice. Many engineering and IT organizations that are inefficient can be moved out of the "not working" category through a migration to the cloud and realignment around cloud best practices.

Establishing a Clear Baseline

Your baseline is where you begin. It should include a number of components: an objective set of metrics, a subjective state of your applications and environment, and a gut-level feel from your key stakeholders.

You'll never know if your migration is successful if you don't understand where you've come from. The best way you can understand what your current environment really looks like is to gather data on:

» **OpEx:** What is your monthly operating cost for equipment? This should include everything from servers and bandwidth to air conditioning to keep your server closet or warehouse cool.

» **CapEx:** How much are you paying, and how often, for hardware, network gear, racks, and so on? Capture all your one-time costs and their recurrence.

» **Usage and capacity:** For every resource you have, what capacity do you have? And of that capacity, how much is used? If you pay for 200 terabytes (TB) of hard drive space and use 150TB, record that. If you typically see your servers' CPU usage at 60 percent, note that, too.

» **Operational headcount and cost:** How many personnel do you have dedicated to operations? How much do those people cost your organization? Use fractions if you need to — you may have an engineer who's focused on server upkeep for half of her time, so note that as 50 percent.

» **Operational hours:** On top of the personnel considerations, how much time is spent in total on operations? Be sure you include work on capital budgets, purchasing contracts, and then, of course, IT and operations hours.

Getting the Right People Involved

A cloud migration is often seen as a technical challenge. However, most successful cloud migrations succeed or fail based on the people involved more than any other factor.

Finding the right people currently on your team

Even a relatively small cloud migration takes a *lot* of people. You need to ensure you have the right people from your existing organization from the first meeting all the way through to the last.

You should be pulling in

» **Stakeholders:** A cloud migration is technical but rarely *just* technical. You need the key decision makers available and ready to contribute opinions, budgets, requirements, goals, and information.

» **Engineers:** Cloud migration requires your application engineers to be clear about their application requirements, components they'll need from the cloud, and how their applications interact with services like databases and file stores.

» **IT:** IT and operations are often separate from engineers, especially if engineering in your organization is analogous to development. In short, whoever runs your hardware and systems has to be a key ingredient in any cloud migration.

» **Managers:** You absolutely, without doubt, will have conflicts in a migration. Migrations are complex, and someone will have to move things forward when agreement can't be reached. Managers — and ideally, a clear hierarchy for critical decisions — are essential to ensure smooth migration.

» **Finance:** Even if cost savings is not a key goal, budgets are complicated when you migrate to the cloud. You'll need someone who can manage budgets and ensure you're on target throughout the project.

» **Project managers:** All these people require a lot of coordination. You're going to need a strong project manager (or two or three) to keep the wheels turning in different departments and across departments. A project manager can ensure you stay on task and on time.

Honestly, this list isn't exhaustive. You may also need people in legal, procurement, contracts, and more. But if you start here, you'll uncover what else you need through these key people.

Finding the right new people

As detailed in Chapter 1, migrating to the cloud is not creating a new one-to-one mapping of your current technology stack and environment. You'll need new skill sets, and they all can't simply be trained. You'll likely need some new personnel.

Here are common additions to teams that facilitate successful cloud migrations:

>> **DevOps:** DevOps represents a modern collaboration between what are traditionally two organizations: development and operations. You need engineers with this principle instilled in them to be successful, and you likely don't have many (or any) of these if you're mostly or all on-premises today.

>> **Cloud specialists:** You should find engineers and operations folks who are experts in cloud computing. You may also want to look for people with experience in the specific cloud provider you're using.

You may not need one of each of these roles, and you may find you need more than one of some.

Training everyone

Now, take every person on your team — from the top on down — and insist they learn cloud concepts. Whether it's online training, an in-person course, a YouTube video, a learning platform, or a training session led by an educator you bring in, you have to get your teams on a level playing field with cloud terms. Have them all read this book and maybe a curated set of white papers.

WARNING

The larger the gap in cloud concepts and understanding from one team member to the other, the more arguments and disagreements will arise that aren't substantive but actually reflect learning gaps.

Coordinating (and coordinating some more)

If this chapter were limited to a single page, that page would be entirely about coordination. The biggest challenge is getting a team with all these disparate parts to work together. It's hard, it's time consuming, and it's at least as difficult as the various technical challenges involved.

TIP

Set up daily meetings with your core members (if you're using Agile methodologies, this would be a daily standup). Set up weekly meetings with the broader team. Insist on a single leader to run the daily meeting and a single leader to run the weekly meeting. Send out clear agendas and action items, and timebox your meetings.

REMEMBER

You should already have clear goals. Every meeting must support those goals, and if you don't make it clear how the meeting results in furthering those goals, you won't have effective meetings.

Choosing an Experienced Partner

If you've never ridden a horse, simply finding one and saddling up may not be the best approach to learning to ride.

Cloud migrations are complicated, multifaceted, and time-consuming. Like riding a horse, they're best done by experienced, savvy specialists. Just as important as finding and connecting the right people on your internal teams is finding the right people to partner with for success.

A company that specializes in cloud migration and has done many of them is a good partner. A company that has done a lot of *different types* of cloud migrations and views your business as unique is a *great* partner.

Here are some other traits of a great partner:

>> **A great partner has clear readiness guidelines.** When you evaluate potential cloud partners, begin by asking what offerings they have to evaluate and assess readiness. Anything short of a well-documented, clear process is unacceptable and tells you that you haven't found the right partner yet.

A great partner provides measurement of your "now" (as discussed earlier); walks you through your specific goals in terms of cost, flexibility, customer engagement, and industry standards; and explains your options without bias.

» **A great partner has tools and products specific to migration.** You wouldn't hire a plumber without a wrench, so don't bring on a partner without similar tools. You should expect products from your partner that optimize and capture your existing workloads and help you simulate your migration before cutting over to the cloud.

You should also expect monitoring tools that provide clear value, both before and after your migration. Cloud providers offer their own monitoring tools, but ask any potential partners what enhancements they offer and how those tools may integrate into your existing operational processes.

» **A great partner engenders trust.** You should trust your partner and, in the best partnerships, even *like* them! If you're constantly handed off to salespeople who seem more engaged by your total contract value or engineers who can't speak to your business goals, be scared!

Great partners provide multiple levels of engagement — interacting with your business goals, your executive team, and then your project managers and engineers. If you don't feel your partner is providing value, find one that does! You should leave each interaction with a strong sense of trust and a greater understanding of your migration.

PARTNERS MATTER

When NASA's Earthdata mission decided to take their massive data store and move it online, they brought in multiple consulting partners. When a $15 billion hedge fund in Washington, D.C., needed to consolidate multiple cloud providers, they brought in an experienced consulting partner. And when a technically savvy NBA team needed to move their business to the cloud, they did the same.

Each of these well-positioned, already-technical organizations recognized that the shortest and most efficient path to success when migrating to the cloud required expertise that they didn't have. By partnering their internal staff with specialized partners, they all built cost-saving, industry-leading cloud environments while minimizing mistakes.

Chapter **3**

Determining Your Migration Strategy

S aying that you're migrating to the cloud is a bit like saying you're eating dinner. It gives a general idea of what's happening, but it leaves a *lot* of room for filling in the details. Are you moving everything? Are you keeping your applications as they are or refactoring? Are you using the cloud as infrastructure as a service (IaaS) or platform as a service (PaaS)? One cloud? Two clouds? Hybrid?

Every detail matters, and very few of those details are arbitrary are inconsequential. In this chapter, learn the common migration approaches and decide which is best for you. (*Hint:* It may be more than one!)

Identifying Your Options

The cloud is not a one-size-fits-all offering. Each cloud provider gives you not just a vendor-specific set of offerings — like Google BigQuery, Amazon Web Services (AWS) Lambda, or Microsoft Azure Container Registry — but variety within your

own architectures. You need to make a decision about your high-level migration approach early, because almost all planning will follow from that key decision.

Here are the key options:

>> Lift-and-shift

>> Cloud-optimized

>> Cloud-native

>> Replace with software as a service (SaaS)

Lift-and-shift: simple and quick

Lift-and-shift refers to literally taking all your architecture as it stands and moving it to the cloud in as close to a one-to-one fashion as possible. Thus, you lift your architecture and shift it into your cloud provider. This is a case of using the cloud as IaaS, and basically keeping all your processes, server profiles, data stores, and file stores intact.

The biggest advantage of lift-and-shift is that it's relatively quick and relatively simple. You're *only* focused on a clean mapping from your environment into your cloud provider's environment.

WARNING

In Chapter 2, I explain that the cloud is not intended to be a virtual closet, but lift-and-shift tries to be just that. Be cautious about thinking of lift-and-shift as a panacea. You may see quicker cost benefits and capital expenditures (CapEx) reductions, but longer-term gains can be elusive.

TIP

To take the greatest advantage of the cloud, consider more sweeping initiatives in a later phase to move your environments — and your staff — more firmly into a cloud-centric way of thinking.

Cloud-optimized: The same, but a little different

A cloud-optimized approach is an incremental step further toward a real cloud-centric paradigm than lift-and-shift. It keeps your application architecture intact, but it seeks to use cloud-based managed services as drop-in replacements for your existing functionality whenever possible.

For instance, instead of using a database hosted on a server, you could replace your PostgreSQL or Oracle instances with managed instances that your cloud provider provides. Instead of large file volumes, you could look at file storage like S3 in AWS, Cloud Storage in Google Cloud Platform (GCP), or Microsoft Azure. You're keeping your application architecture intact but taking advantage of key services to reduce your management and operational overhead.

Another option is to extend your critical applications to use cloud infrastructure, while keeping some components in your data center. This is called *hybrid cloud.* For example, if transaction time is critical for a back-end data tier in a medical or financial application, maintaining application performance is often better done with local, high-performance storage assets, while other application and web components can be moved to the cloud to take advantage of advanced scaling capabilities when needed.

TIP

For most basic services, you can simply search the web for your preferred cloud provider and the service, and you'll get results that suggest cloud-optimized alternatives. For instance, searching for "AWS file storage" returns articles on the Elastic File System and S3, while searching for "Azure database MySQL" gives you information on Azure's managed MySQL instances.

Cloud-native: Not at all the same, but turbo-charged

Cloud-native is a complete commitment to the cloud and, often, to a specific cloud provider. In this model, you're taking the functionality of your application — a user interface accessible on the web, a data store, an application programming interface (API) — and looking to refactor and even rewrite your application based on cloud-specific functionality. So, you may use a serverless technology to serve your front end, worker threads to return responses for an API, and a columnar data store for some data and dynamic file storage for other data.

In other words, you're evolving your application from a server-based paradigm to a cloud-based one. This is by far the most difficult and complex migration, but it also can offer the most extreme gains in performance, as well as massive reductions in cost and maintenance.

This approach depends heavily on your people and your coordination (see Chapter 2). Without a great team of cloud-savvy engineers, cohesive management, and an experienced partner, cloud-native migrations rarely succeed.

Replace with SaaS: Buy over build

In some cases, you really don't need a lot of custom applications. Perhaps off-the-shelf solutions would provide you the functionality you need while still offering your business the customization that's required to differentiate your business. You want to concentrate your people on your key value adds and distinguishing characteristics. SaaS applications can often take non-key services off your plate, resulting in fewer distractions to your core business.

In this case, you may choose to migrate to that software, instead of actually moving your own applications. This can be a fantastic solution if you don't need as much flexibility but really want to move quickly and with assurance of a tested platform as the outcome.

Choosing the Right Strategy

At its simplest, you can evaluate the basic pros and cons of each approach, compare those to your goals for the migration, and make a decision. Table 3-1 lists the major items to consider.

TABLE 3-1 **Effects of Various Migration Strategies**

	Lift and Shift	Cloud-Optimized	Cloud-Native	SaaS
Degree of change to architecture	Very low	Low	Very high	N/A
Complexity	Low	Medium	Very high	Medium
Operational overhead	High	Medium	Medium	Low
Reduction in cost	Low	Medium	Potentially very high	Varies
Increase in productivity	Medium	High	Very high	High

Realistically, this decision is never easy, and each option is a trade-off. Cloud-native has huge potential for cost reduction, improving productivity, and attracting and energizing top engineering talent, but it brings with it significant complexity and will likely require a lot of new training and new hires. Additionally, even if phased, this option can be quite risky and expensive compared to less volatile strategies.

On the other hand, while lift-and-shift is very straightforward, you'll realize only a fraction of the benefits of a cloud-optimized migration, let alone a cloud-native one.

SaaS is in many ways the most variable. Different partners with different solutions offer wildly different price points, advantages, and tradeoffs. If you examine SaaS as an option, you'll need a completely different decision matrix for evaluating between different offerings.

It's very easy to become enamored with one approach or another. Perhaps you really love the idea of the simplicity of a lift-and-shift, or you think you could attract top-notch engineering talent with a cloud-native approach.

The key is to evaluate these strategies against your original goals (see Chapter 2). If your prime consideration is cost, it doesn't matter how intriguing and expensive SaaS may be; you may need to ignore SaaS because of the primary cost factor. If you're in need of a next-generation application, but cloud-native looks intimidating, consider a partner or phased approach instead of abandoning your key goal.

Ultimately, you should change your strategy to accommodate your goals, not the other way around. Sometimes there is a middle ground (of sorts). Read on!

Migrating in Multiple Phases

Sometimes the best strategy to choose is actually more than one strategy. A phased migration allows you to move through more than one strategy in an incremental approach.

Consider lift-and-shift. This is the least complex strategy with the least architectural upheaval. That typically translates into

the easiest (in relative terms) migration. The big benefit here is that you're "in the cloud," albeit without a lot of optimization or maximized benefit.

But if maximizing cost or attracting better engineering talent is your ultimate goal, then lift-and-shift should just be your *first* migration. You may want to consider moving from lift-and-shift to cloud-optimized. You'll increase your cost savings, and while you still have to do some re-architecting, you've *already* overcome the initial migration to the cloud.

Put another way, you can actually break your cloud migration into successive smaller cloud migrations. Each migration takes the simplest step from your current state to your next desired state.

If you follow this approach, the primary extra spent resource will be time (and that often incurs cost). You'll never be able to perform two phased migrations in the time it takes to perform one larger migration; however, that isn't the same as saying bigger is better. Taking longer may ultimately save you a *lot* of headaches or multiple failed attempts at migrating.

As with most things in the cloud, you and your team will have to exercise judgment and make the best decision based on *your* organization's business goals.

A phased approach is often a great idea, but it's not a one-size-fits-all solution. You won't always find intermediate steps between your current state and where you want to get. SaaS is a great example; there's rarely an advantage in doing a lift-and-shift before going to SaaS.

Regardless of your approach, a phased migration is still a *complete* migration. That means you need to establish goals, set up kick-off meetings, assemble the team, have signoffs and contracts, do cost assessments, and have business reviews. You may abbreviate some of these meetings at the end of one phase and the start of another, but don't skip steps. The phase will suffer, which means the overall migration will suffer, too.

Planning for Surprises

Every cloud migration comes with its share of the unknown. No matter how well planned, and regardless of whether you choose lift-and-shift, cloud-optimized, SaaS, or something altogether different, you're moving a significant, valued part of your infrastructure to a new environment that you don't control. That's a recipe for uncertainty.

With that uncertainty comes tremendous value. But how do you plan for uncertainty? You can't ignore it. You can't accurately estimate it. So, what do you do? Here are my tips:

>> **Favor conservative estimates.** There are plenty of times to be aggressive, challenge your teams, and set hard deadlines. A cloud migration is a terrible case for this approach. You don't have to sandbag, but try to find realistic, if not slightly conservative, estimates. Also, be sure to plan time for meetings and handoffs!

>> **Lean on partners.** Experience is the best insurance against the unknown. A partner here can be invaluable in identifying potential problem areas. This is also where finding a partner that has done a migration *as close as possible to yours* is critical.

>> **Simulate your migration without time constraints.** One of the best things you can do is to actually do a sample migration. Ideally, this would be a prototype team that is working prior to your major migration initiatives. A team like this — with the right tools — can uncover a lot of the unknowns that would otherwise plan your carefully scheduled actual migration. Chapter 4 digs into this topic in much more detail.

Chapter **4**

Migrating Before You Actually Migrate

N o matter how much you've learned about cloud, assembled the right time, conducted the right (and effective) meet-ings, and carefully laid out a migration strategy, migration is still very hard. There is almost no chance that things will go well on your first attempt.

Sounds ominous, doesn't it?

It's okay, though. If you know this going in, you can plan for problems and take the extra care that's required to ensure that the problems you're bound to encounter *improve* your ultimate migration, rather than derail it.

In this chapter, I explain just how much you can do before your actual migration to ensure success. Through tools, expectation setting, and (even more) planning, you can reduce your migration time and increase your end value.

Modeling Your Migration Beforehand

The absolute best thing you can do before migrating your environments, applications, and workloads to the cloud is to model your migration beforehand. Modeling here means more than just "test." It involves

» Creating a representative workload of your desired migration off-cloud to understand your actual resource needs

» Validating that your representative workload will work in your target cloud environment

» Testing your representative workload in your target cloud to validate expected performance and cost

» Tuning and tweaking your representative workload

Application discovery and dependency mapping

For any migration plan, you'll also need to understand the boundaries and landscape of services that support your applications. These applications' interdependencies help determine how much traffic you'll have coming out of your cloud environment, which translates into cost. You'll also learn which applications may best be served by staying on-premises, the design of your representative workloads, and how to schedule your migration events.

This is a great area to look to your partner for help and even delivery. The best partners employ advanced techniques and statistical methods to analyze and produce a detailed set of application dependency communication maps.

Building a representative workload

The most important technical task in your entire migration — from the moment you decide to perform a migration to the final "all clear" — is building a representative workload. This one step will guide nearly every other decision you make. Pair this with the right people and tight collaboration, and your chances of success soar.

REPRESENTATION, NOT DUPLICATION

It's important to keep in mind that you should build a representative workload, not a complete copy or representation of your entire environment. So, if you have five applications, each with a web server, application programming interface (API), and database, all of varying complexity, you may create *one* simple workload with a web server, API, and database, and then apply a multiplication factor (in this case, 5) to your results.

The key here is to keep things simple. You're not trying to get exact numbers; instead, you're trying to get a *reasonable* estimate of projected results. You don't want to spend time building a workload; you want to spend time analyzing results.

A representative workload is just a model of what you want to migrate. It's a set of resources and components that behave in a similar way to your actual migration resources, but ideally, it's smaller and easier to move around.

You're going to use this workload over and over, so take the time to automate its creation, teardown, and re-creation.

TIP Automation is an important part of the cloud. If you currently use manual steps to set up your environments, this is a good time to replace those manual steps with scripts. A tool like Terraform (`www.terraform.io`) is a great place to start, and it works with any cloud provider.

Building affinity groups for different types of workloads

If you have two different workloads that are wildly different, you may need two different workloads to represent them. That's okay. In fact, you can group your similar workloads into *affinity groups* (similar workloads or resource stacks that share characteristics).

So, you may have three affinity groups in the set of things you want to migrate:

>> **Web applications:** This group may have applications with a web-based front-end, an API layer, and a data store.

>> **APIs:** This group could store APIs that don't have web or user-facing front ends, but instead just code backed by a data store.

>> **File stores:** This group is just what it sounds like: raw file storage that is accessed or mapped to drives on the network.

>> **Virtual servers or environments for software as a service (SaaS):** You may have software that runs as a service and just needs a server instance and a database.

You can create a representative workload for each group, and then validate each workload independently according to the number of things in each group. This extra granularity will help increase your accuracy in planning and forecasting.

Validating your migration using your workload

Now that you have a representative workload, you should measure and write down your expectations for that workload. What CPU requirements do you have? What storage and memory require-ments? What network latency is acceptable, and does that latency vary for outbound versus inbound traffic?

These are all items you should have from earlier in your planning (Chapter 2 talks in detail about your baselines), but now you're validating those with running resources. You can then simply multiply your findings by the number of representative workloads you'll be running. So, if you have one web server/API/database in your representative workload and need to support eight, just multiple your resource validation numbers by 8.

A linear scaling like this isn't always accurate. However, in most cases, it's good enough to help you find major gaps or holes in your understanding, and that's all you're looking for at this stage. However, if your representative workload is *not* representative — if it's oversized or undersized — then all your calculations will be similarly off base.

Using Tooling to Validate Your Migration

The process of coming up with representative workloads is relatively straightforward. The process of validating those workloads, deploying them to a cloud provider, getting performance and resource numbers, and projecting those out for your actual workload is not.

This is an area where getting some help can go a long way — both from a support-from-real-people perspective, and a help-from-mechanical-tooling perspective.

Asking your migration partner for planning tools

Your migration partner is an essential resource at this stage. Their experience really should start to benefit you — in planning, in projections, in aligning your goals to your digital transformation, and even in helping ensure you have the right teams and the right people. Ask them for help in measuring resource utilization, projecting costs, and even migrating your representative workload.

Some migration partners will actually be leading the charge at this stage. The best will help you develop your representative workload and even provide you tooling to simulate a deployment to your cloud provider with on-premises resources.

You should also ask your migration partners to validate your strategies and models. In fact, many will offer to help you develop these in the first place, which is even better. The value of an experienced partner in a cloud migration really cannot be overstated.

Getting to know your cloud provider's support

Any major cloud provider supplies accounts with access to support resources, and for even medium-size accounts, you'll likely have a technical account manager (TAM). TAMs are dedicated to helping your migration go well. They often have access to tools and knowledge that are priceless for a good migration.

Many people don't realize this and never even reach out to their TAM. Call or email your account manager or support and ask if you have a TAM. If you don't, ask what minimum requirements must be met to get a TAM. Often, a higher level of support is all you need, and a few hundred bucks a month may get you that support — and access to your TAM.

Knowing what your tools should tell you

The combination of your own resources, your TAM, and your partner's tooling should allow you to do the following:

» **Deploy a workload.** Whether you have to run a script or push a button, you should be able to deploy (and more important, redeploy) your workloads to your cloud provider without lots of manual intervention.

» **Measure resource usage by type.** Once deployed, you should be able to get objective (numerical) measurements of disk space, CPU usage, network bandwidth, database size, and just about anything else related to your workload's usage of cloud resources.

» **Project costs.** With those usage metrics, your tooling should tell you how much your workload would cost to run over a day, a month, or a year.

» **Tune resource usage.** Now you can tune things. What if you want to expand disk usage, or reduce network throughput? You should be able to make these adjustments and re-project costs.

» **Plan for expansion.** What if you need to scale out, or add a secondary environment? You should be able to plan costs for these variations that go beyond just ramping up disk space or the number of file stores you use.

Getting It Right

You've selected the right partner, you've got tools in place, and now you need to test, test, and test again. This effort will pay off because it significantly reduces risk when you actually do perform your actual migration.

AUTOMATION IS EVERYTHING

You've read about automation at least three times by now, and it could easily be a few pages of material on its own. You should automate every step of your build and migration, and any time you do a manual step, figure out a way to turn that manual step into an automated one.

The addition of a good DevOps engineer will help a lot here. Automation is a key part of DevOps culture. When it's time to perform your migration to production, it's essential to ensure that no manual intervention is required.

TIP

Here are the keys to using this phase to serve you and avoid lingering problems:

» Document every issues that arises, especially how that issue showed up (dropped connections or a 404 web error or lack of access to the console) and how you resolved it (added more memory, changed a route, added an admin user).

» Automate every single change you make. Nothing gets changed manually unless it's immediately automated!

» Keep a running deployment log of changes.

The entire cycle here is to test, observe, fix, and then repeat until you're ready to migrate.

Setting Your Expectations Correctly

It's important to have the right goals for this phase of your migration. Just as you need to have clear goals and measurements for your overall cost savings, productivity increase, and everything else discussed in Chapter 1, you need similarly clear objectives for your preparation and tuning of representative workloads.

Focusing on deployment, not architecture

Here are some great goals at this step:

>> Become confident in understanding the resources needed in the cloud to support your workload.

>> Automate and make repeatable your deployment workflow.

>> Uncover hidden or undocumented deployment steps in your planned migration.

>> Have order-of-magnitude cost projects that you can compare to your original goals.

As a contrast, here are some goals you should *not* have:

>> Optimize the architecture of your representative workload.

>> Implement managed services or other cloud-specific aspects of your workloads.

>> Highly tune costs of your representative workload.

Put even more directly, your focus at this stage is on smoothing your deployments. You want a repeatable, predictable deployment of components that model your environment. You do *not* want to change your environments radically at this step.

Planning failure, not just success

Another key step of this phase is to clearly define processes for when something goes wrong. Every failure to deploy or migrate your test workloads should inform how you'll respond if there's a failure in your actual migration. Write down who troubleshoots, what tools are used, and how remediation is agreed upon.

In other words, you aren't just building a process for a perfect migration (although that would be nice!). Instead, you're building a process to handle all aspects of migration. You should have steps that cover what to do when migration goes great, but you should also have steps to cover what to do when migration goes poorly.

Chapter **5**

Flipping the Switch

You've done all the preparation! You have the right people, you've been having great meetings, and you've tested your migration multiple times. You have a clear set of goals and you've set a baseline. And you've adjusted that baseline based on your representative workloads.

Finally, it's time to actually migrate your workloads to the cloud. Flip the switch — but don't be surprised if things *still* don't go perfectly. That's okay, though. You're already prepared for what–ever problems may arise.

Making Sure You're Ready to Migrate

You've done a lot of hard and often tedious work at this point. But that's good! That means that what's next — your actual migration — should be pretty straightforward.

TIP

As a final checklist, you should have all the following before you migrate to your cloud provider:

» Well-defined teams that are all available to perform the migration and escalate any issues that arise

- >> A technical account manager (TAM) or support representative from your cloud provider, ideally available for help
- >> A migration partner (and team) to help you migrate and mitigate issues
- >> Baselines and tests from your representative workloads to measure your actual migration against
- >> Contingency plans based on the various failed and partially failed test migrations

If you have all of these, then it's time to migrate! As simple as that sounds, this step is really that straightforward.

Thinking of Your Migration as Another Practice Migration

Think of your migration as just another migration in a long run of practice migrations. If something goes wrong, the process is no different. You roll back, capture lessons learned, make corrections, and automate those corrections. Then you do the whole thing over again.

REMEMBER

It's important that your actual (final) migration runs without *any* errors. In other words, if you have to change *anything* post-migration, you should automate that change and rerun the migration. This is the only way to be sure your process is repeatable.

Also realize that you've created something else that's pretty important: a repeatable process for deploying your infrastructure. So, if you need to set up in another region, you can. If you need to set up duplicate environments in the same region, you can.

All of these situations just require a working deployment, and your hard work has given you just that.

REMEMBER

Practice doesn't make perfect; *perfect* practice makes perfect.

Chapter **6**

Managing Your Cloud Environment

It's easy to consider your migration complete when you have everything you wanted in the cloud and running. But there's still important work left to do: You have to keep those resources running. Even more important, you have to continue meeting the business and technical goals you set weeks and months ago.

This chapter can't possibly tell you everything you need to successful manage a cloud environment. But it does get you headed in the right direction and ensure you capitalize on your successful cloud migration.

Visualizing Your Environment

Top performers in nearly every sport visualize their upcoming competitions to gain a competitive advantage. In the high-performance sport of business, the same is true. Successful organizations have tools that provide them clear pictures of their cloud environments. This is not just monitoring, but understanding how your resources are laid out and connected, how you're using regions and zones in your provider, and what connects all these environments.

TIP

There are a number of good free tools for inspecting and visualizing your environment, and your cloud provider may also provide tooling here. You typically point these tools at your accounts, and they give you a diagram (or more), as shown in Figure 6-1.
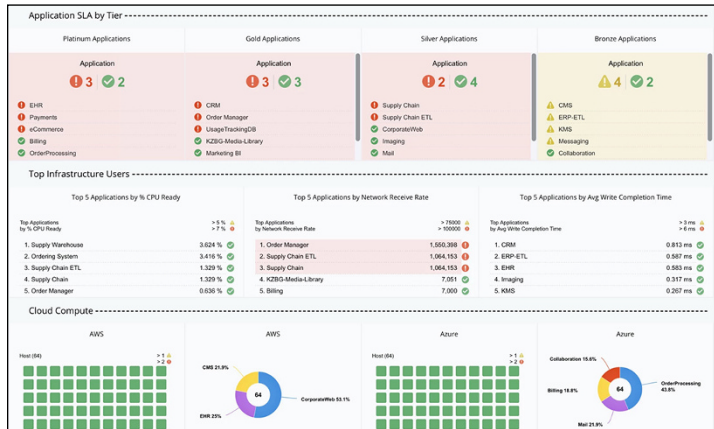

FIGURE 6-1: Visualizing top-level cloud-workload status.

REMEMBER

As helpful as these tools are just for general understanding, they're also great for tracking down inefficiencies. Take some time to trace a request from a customer through your various resources, and make sure that you're not doing unnecessary routing or wasting processing power. The increase in efficiency can be monumental.

Selecting Cloud-Ready Tools

More than one company has had a great migration go off the rails because a certain piece of software doesn't function in the cloud, or has only limited functionality in that context. This is an area where you shouldn't simply take a vendor's word for it; you should migrate and test your tools before you go live with the same rigor that you test your own applications.

REMEMBER

Not all tools that run in the cloud are created equal. Some tools will run in the cloud, and others are built *for* the cloud. Unlike your application, you should seek to convert to cloud-native tools as quickly as possible. This is an area where a phased approach *will* cost you time and money.

Monitoring (the Smart Way)

Although monitoring certainly falls into the set of tools you'll want to select carefully — and select for cloud usage — it's likely the most important thing you can do for the health of your application and your business.

Monitoring everything

One of the best things about the cloud is that monitoring is generally either free or so cheap at basic levels that it's nearly free. And if you choose third-party tools, those also often are either free or incur a nominal payment.

The good news is that you don't have to monitor just one set of resources or one aspect of those resources. You can monitor *everything* — and you should! You should collect metrics on every resource, on CPU usage, on network usage, on disk space, on requests and responses, on errors, and on pretty much anything else you can think of.

The point is that by collecting data, you preserve flexibility. Maybe you'll need to track network requests in six months, and that historical data you're collecting now will become essential. With monitoring and storage of metrics costing you only pennies, you should be liberal with what you want to collect and how much of that data you keep.

Reporting toward your goals

The next step is to build reports from your monitoring. Here, you can be more selective. Some solutions will automatically build application topology maps, alerting, reporting, and displays using artificial intelligence (AI) and machine learning (ML) capabilities. Take time to customize or build out reports (and often, real-time dashboards) that show you what you want to see. This is where your goals surface once again. If cost is a primary driver, create graphs on cost and make them prominent parts of a cost utilization dashboard. If you're after increased traffic, report on traffic, errors, request time, latency, and number of unique users.

In short, you should monitor everything, but report on your goals. Building dashboards and reports takes time, so this is where you *should* be selective. Then use those data to evaluate if you really are meeting your goals, and adjust accordingly.

Recognizing that unbounded costs are a real thing

Even if you aren't considering cost a primary driver, you should have alerting and monitoring set up around costs. Cloud providers are typically unbounded in cost; that means that you can't set spend limits. You pay for what you use, and providers will typically let you use whatever — and however much — you want.

That's a big deal. But the selections available are often complex and hard to understand. If you aren't paying attention, you can easily amass thousands, and even tens of thousands, of dollars in charges because all your developers spun up databases of their own and your production application scaled out but was never set to scale back down. Monitor costs and you'll catch this and be able to head off any unexpected costs quickly.

Buying versus Building

One important decision you're going to have to face both maintaining and moving forward with your applications is whether to keep building out your own software and tools versus buying existing ones.

This is always a consideration, but time and time again, the move to the cloud has proven to be a major inflection point for companies, and a great time to evaluate (or reevaluate) technology decisions.

Building

Almost every organization with an existing engineering group will lean toward building software, tools, and applications. It's likely why you created an engineering group — and what is having engineers on hand worth if they're not building something?

Building ensures ownership, intellectual property, deep understanding of what's been built, and usually a greater degree of customization than is possible with off-the-shelf software. It also tends to increase engineering morale and, in many companies, can increase the overall company value by providing proprietary assets and competitive advantages.

The problem with building is ultimately time. It takes time to build software, and that time costs money, opportunity, and potentially market share. It also requires your team to be very good at anything you build. This could gain you breadth but cost you depth in other areas.

Buying

Buying may sound repugnant, especially to engineering-heavy organizations. But the reality is that buying a solution — whether for tooling or entire software suites — is often the faster and more economical choice.

TIP

Consider building in one focused area that capitalizes on your organization's strength, expertise, and value propositions. If you're an ecommerce provider, build your core product and order system. If you're a data analysis firm, build your most complex and valuable algorithms. Then purchase outside of those core areas. You'll move much more quickly and often get products from organizations that are building out of *their* strengths.

REMEMBER

You may be thinking that buying is expensive. But buying is rarely more expensive than building. Just don't buy in an area where you need to capture value or maintain intellectual property.

TIP

If you decide to buy, begin with your migration partner. Do they have solutions for you in terms of tooling and software? If not, who have they worked with and integrated with before? The more you can leverage an existing relationship — technical or company-to-company — the more likely your purchase will be a win.

Chapter **7**

Ten Cloud Migration Challenges

Here are ten challenges that you'll need to overcome to ensure a successful cloud migration.

Setting Clear and Flexible Business Goals and Priorities

You need clear goals for your migration (see Chapter 1). But as you move through migration, you need some degree of flexibility, too. You may need to phase your migration, or you may find that although cost is a driver, you'd be willing to give up some cost for increased scalability and redundancy.

Your goals should be clear, but they must have some room for the learning you'll do during migration. If you have a change in priority, simply document that change and make sure the team knows what they're (now) shooting for. Then make sure your metrics and baselines also reflect that new set of goals and priorities.

REMEMBER Change is not bad if it's well communicated.

Identifying What Should (and Should Not) Be Migrated

Clear goals will give you insight into what you want to migrate and what you may not. If high security of your data and blazing throughput are key business and technical goals, you may want to keep your critical data onsite, and build a high-speed virtual private network (VPN) to your cloud. If cost and low maintenance are drivers, you may want to migrate every resource you have.

TIP Make clear decisions about which resources go to the cloud, share those decisions, and stick with them. If you need to make changes, consider an additional phase down the line.

Rearchitecting, Rewriting, or Replacing Applications

Simple migrations are easier than complex migrations. Migrations that involve re-architecture and rewriting often are trickier than a simpler lift-and-shift.

TIP Consider breaking your migration into steps. Move an application to the cloud, convert to managed services, and then rewrite portions of the application. This phased approach will significantly reduce risk and complexity if you can afford the longer timeline.

Meeting Compliance and Regulatory Requirements

This is a big one! If you have compliance or regulatory concerns, you should either engage a partner or a team member that has previous experience in cloud-based compliance. These issues are quite complex ones in the cloud, with unbounded costs and emerging policy considerations.

WARNING Do *not* try to figure this out for the first time during your migration. Instead, work with your experienced team members early to reach out and get clarity on requirements, and check for compliance at every step of your migration.

Understanding Your Team's Capabilities

Migration is an area where you shouldn't be overly optimistic about your team's capabilities. Good team members can come up on cloud skills, but you should bring in talent — employees, consultants, and partners — to fill in the gaps if you want your migration to move smoothly.

TIP Consider building a matrix of responsibilities and fill in who on your team will do each task. Any gaps should be filled *before* you start migrating.

Keeping a Handle on Your Costs as You Migrate

You need to do more than set a budget for your migration and then check that budget every few months. Costs in migrations can spike, often at unexpected times — perhaps when you create a new database multiple times, or pull a lot of files you hosted on the cloud back out of the cloud.

TIP Checks on your costs should be a part of your weekly cadence, and you should have a well-defined escalation and approval plan when costs look to overrun.

REMEMBER Overrun is not necessarily bad if the overrun could predictably result in long-term improvements toward your business goals.

Setting a Well-Controlled Cadence for Transition

You should have weekly meetings that provide forward progress, sprints with regular transition outputs, and a road map that you reference and update weekly, if not daily. The more reliable and predictable your schedule, the smoother your transition will go. You'll also be able to tell more quickly if things are falling behind.

Right-Sizing Your Application Workloads before Migration

You can right-size your application — hard disk space, allocated CPUs, database shards, and so on — before or after you migrate. The best solution, though, is to do both.

If you take some time to move over environments that are already space-optimized, your baselines will be more accurate. This also lets you separate two concerns: right-sizing your applications, and the savings you get from your cloud provider.

Monitoring and Managing Your New Hybrid or All-in-Cloud Environment

You should already believe that monitoring is a key part of operating in the cloud (see Chapter 6). But monitoring is an ongoing process. You can't just turn on monitoring and then never touch things again. As you introduce new applications or re-architect existing ones, you'll likely need to tune your monitoring.

Consider setting up a quarterly monitoring review for all your monitoring — onsite and in the cloud. Use this review to validate what you're monitoring, align with any new or updated business goals, and adjust your metrics accordingly.

Measuring and Quantifying the Results

You need to decide what metrics you're using to quantify success (see Chapter 6). Is cost your primary driver? Is productivity? What about uptime or users served?

Make clear decisions about which of your monitored metrics define success, and try to consistently use those as key performance indicators (KPIs).

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- Optimize for ongoing success

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