HARVARD UNDERGRADUATE CBE

[Redacted]: Midpoint Presentation

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What is Public Cloud?

Public Cloud is a oft-misused term. We define it here, in comparison to Private Cloud, as a preface to the rest of the presentation, given that this term appears frequently.

We define Public Cloud as a service for enterprises that allow them to outsource their IT infrastructure and needs. A Public Cloud provider makes resources and services, such as virtual machines, storage, and applications, available to enterprises through a payment model. Alternatively, enterprises may turn to Private Cloud which generally has less functionality and fewer benefits, but can be chosen for specific enterprise reasons.

- This presentation makes a distinction between Public Cloud and Private Cloud. Public Cloud is through a Cloud provider, such as [Redacted], Azure, or IBM Cloud. Private Cloud is when enterprises construct their own private Cloud with in-house technology teams.
- It is often argued that Private Cloud relegates more control to an enterprise. This is a myth, since enterprises have as much control over the workloads if they migrate to the Public Cloud, and doing so has significant advantages compared to staying on-prem.

Key Aspects

Public Cloud allows enterprises to reduce their IT costs by outsourcing this essential enterprise need. Private Cloud requires management, maintenance, and updating to be the responsibility of the company.

Public Cloud allows for scalability because rather than constructing new warehouses, enterprises can immediately contract out their specific need.

Public Cloud providers generally have a utility cost model, which means that enterprises pay for what they use, so there is little waste. Private Cloud requires that datacenters are running full time, regardless of usage.

Public Cloud is a general term that encompasses many functions and use cases. These include Cloud storage, online software, website hosting, and Cloud based development environments.

InteRoute, *Cloud Computing*, *Red Hat*, *Expedient*

Section 1: Late Adopting Enterprise Phobias

Section 2: Benefits of Migrating To The Cloud

Section 3: How To Migrate To The Cloud

Section 4: How To Decide on a Cloud Provider

Late Adopting Enterprise Phobias

Over the last decade, many tech-forward enterprises have made the switch to using the Cloud to reduce costs, improve efficiency, and increase security. However, many late adopting enterprises have not made the switch. We believe there are six key fears that prevent enterprises from migrating to the Cloud, and rather than being rational business decisions, these are irrational and detrimental.

Prototypical Late Adopters

Late-adopting enterprises tend to be organizations that have data privacy and security concerns because of the industry in which they operate.

Key Features

- Late adopters may have **serious physical assets** that require rigorous security (utilities, transportation)
- Late adopters may be in *old money* industries like energy, shipping, or banking; their **inertia prevents them from migrating** to the Cloud (retail, entertainment)
- Late adopters may have **sensitive consumer data** (finance)
- Late adopters **may not know the benefits** that the Cloud can convene on its business practices (retail, entertainment, utilities)

> "Winners in banking are going to be great technology companies"
>
> Rob Alexander, CIO of [Redacted]

Interviews with Harvard Faculty, *Computer Weekly*

- In general, enterprise phobias are harbored due to a misunderstanding of the Cloud. These phobias have come about because of salient but atypical stories that appear in the news, but are unrepresentative of the public Cloud.
- Concerns include **security**, **privacy**, **vendor lock-in**, **latency**, and **data sovereignty/compliance**.

Finance	Because of their extensive use of private financial data and proprietary algorithms and software, finance and banking is scared to move to the Cloud primarily due to a privacy and security concern.
Utilities	Utilities companies have physical assets that cannot afford to be compromised. Switching to the Cloud—no matter how great a service—is a hard sell due to the security concerns.
Transport	The transport industry deals with inertia within their market and an unclear value proposition of migrating to the Cloud.
Retail	Retail companies face escalating pressure from web based marketplaces, but are generally unsure/unclear of how migrating to Cloud services can help their business.

Key Takeaway

Many late adopters either do not know what Cloud can do or are scared of what Cloud *might* do to their business.

Key Enterprise Fears

There are six key enterprise fears related to use of the Cloud. We sequentially address each of these fears.

Enterprise Fears

- **Security** - protection of data from external attacks
- **Privacy** – access to data
- **Vendor Lock In** – being too reliant on a single vendor for critical business function
- **Data Latency** – speed of data access
- **Data Sovereignty** – location of data storage
- **Compliance** – compliance with government regulation related to data storage

Security Concerns

Security tends to be one of the biggest concerns when moving to the Cloud because data is no longer siloed in one place; it is "in the Cloud."

SECURITY CONCERNS

We define security as the technologies and practices designed to protect data from external threats.

MYTHS & FEARS

- Migrating data to the Cloud will allow enterprise data to be more easily breached, stolen, or attacked
- These sorts of attacks lead to severe public mistrust and fraud potential
- Cloud companies have less of an incentive to keep enterprise data secure than the enterprises themselves

REALITY

- Public Cloud companies are able to **invest more into security** simply because of their scale
  - This includes physical datacenter security, robust compliance, and higher cybersecurity
- Many also integrate third parties such as Symantec and Splunk to intensify security
- Cloud companies are incentivized to ensure data security as a differentiating market factor

Key Takeaway

While enterprises may fear that the Cloud is less secure than staying on-premises, Cloud providers have a significant advantage in security due to scalability and investment. Migrating to the Cloud is more secure than staying on-prem.

Interview with Harvard Faculty, *Wired Magazine*, *Gartner*

Dispelling Privacy Concerns

Privacy concerns are of key interest to enterprises, and scare many into not adopting Cloud or adopting a limited Cloud model. However, most Cloud providers have **rigorous privacy assurances** that address most of these concerns. Cloud providers will not look at an enterprise's data, by contract.

Cloud providers encrypt data, give clients control over *where* data is stored (e.g. only in North America) and who has access, and only disclose data when the law demands it (e.g. subpoenas).

Privacy

Privacy concern regarding the use of enterprise data, where it is stored, and who has access to it is another factor resulting in lower adoption of the new technology.

We define privacy to be who has the **ability and permission** to view data.

Companies that have sensitive data, proprietary algorithms/data, or any data that has the potential for misuse and abuse are **concerned about the privacy** of their data.

- Data will be viewed by agents outside of my enterprise.
- Data will fall into the hands of a competitor.
- Data will be used to undermine my enterprise and reduce my competitiveness.
- Data will be mishandled by a Cloud provider because they do not share the same incentives as me.

Key Takeaway

In the 21st century, data is king. Concerns over the privacy of data are important to address and enterprises are rightfully concerned about data because its misuse/abuse can change the course of their enterprise. These concerns are generally unfounded.

Interview with Harvard Faculty, *Interview with [Redacted] Digital Engineer*

Addressing Privacy Concerns

Most Cloud providers can easily address privacy concerns transparently and comply with even the most rigorous protocols to serve enterprise needs.

Will data be viewed by agents outside my enterprise?

This is simply not the case. In general, hosting data on the Cloud does not give anyone access to your data. **The CIA hosts much of its data on [Redacted]** because it knows [Redacted] cannot look at the data.

Will data fall into the hands of a competitor?

Once again, this is a largely irrational fear. In general, Cloud providers have rigorous assurances that protect data both from external threats and permissions controls from within.

Will data be used against me?

Cloud providers cannot look at a client's data. Competitors cannot look at another enterprise's data, even if they are on the same Cloud. Other than complying with subpoenas, Cloud providers never have to release data, and will never do so.

Will data be mishandled by the Cloud provider?

Cloud providers have no incentive to mishandle a client's data because if they do, and the story leaks, their entire business is finished. Cloud providers treat client data with the utmost care and invest significant resources into providing high privacy.

Interviews with Harvard Faculty

Enterprise Customers Retain Data Ownership

Enterprises may be unfamiliar with differences between private Cloud and public Cloud, since both enterprise options are related to the Cloud.

There is confusion over data ownership rules when it comes to using the Cloud. Data ownership remains with enterprises in both private and public Cloud options.

PHOBIA: DATA IS LESS SECURE ON THE PUBLIC CLOUD

- By-product of Cloud being associated both with personal data and enterprise data
- Headlining privacy scandals, e.g. **Equifax Breach**
- Customers lose ownership of images, documents uploaded to Cloud

REALITY: ENTERPRISE CLOUD DATA IS MORE SECURE

- Contracts explicitly state **data ownership remains with enterprise**
- Transparent data management gives enterprises full control over data
- On-prem databases (e.g. Facebook) have seen significantly more cyberattacks than public Cloud

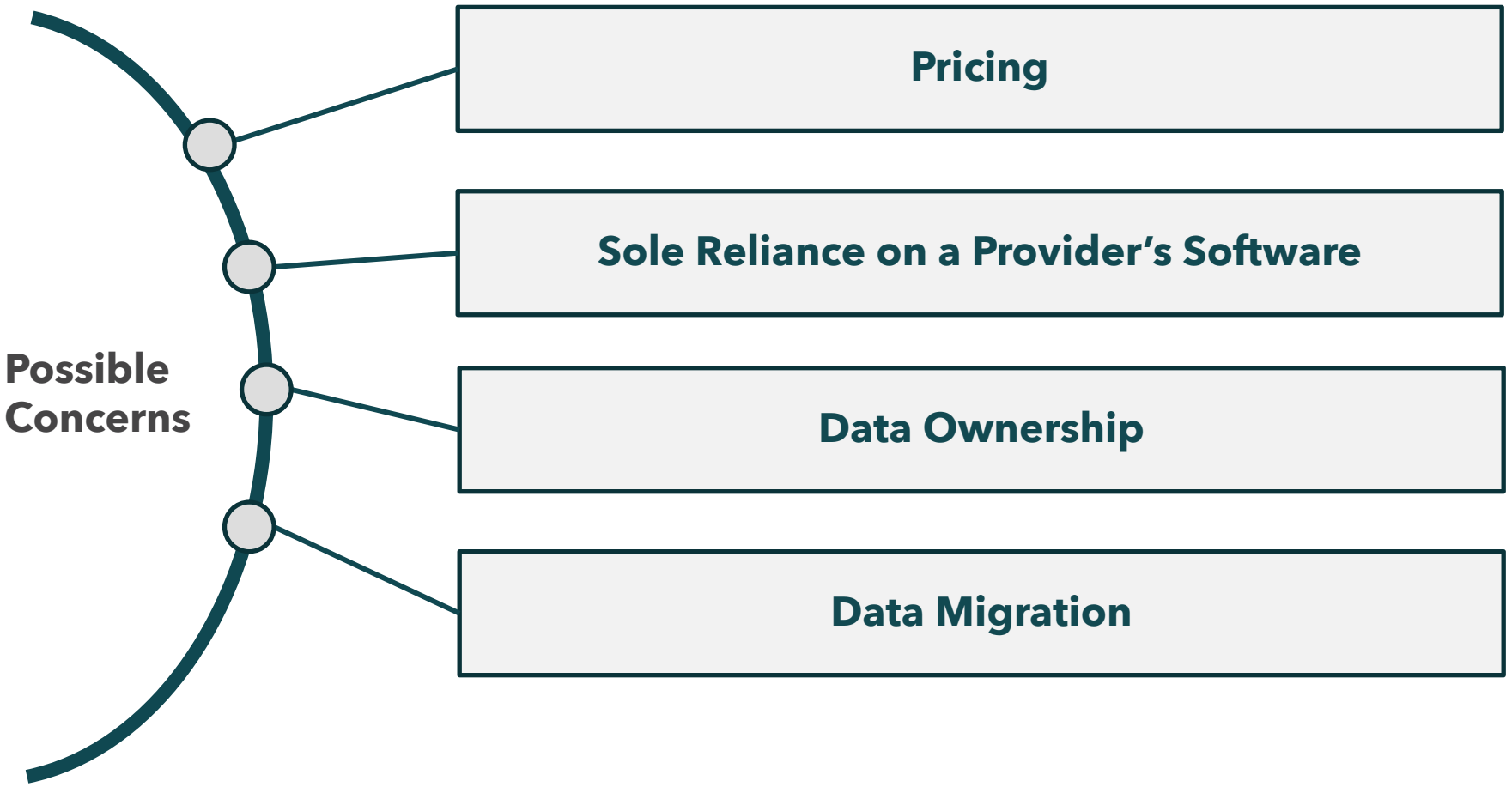
Key Takeaway

Private and Public Cloud are similar in terms of ownership. Data ownership remains with the enterprise in both cases. This is explicitly stated in enterprise Cloud contracts. Data is more secure on the Cloud.

iData Security and Privacy Protection Issues, *IDG*, *Cloud Computing*

Fears Surrounding Vendor Lock-In

Customers often fear that switching to the Cloud will be expensive and cause over-reliance on a provider's proprietary software.



InformationWeek

How the Cloud Reduces Vendor Lock-In

The fears surrounding vendor lock-in do not hold up to light, given that most Cloud providers have in-built flexibility and compatibility, as well as no contract lock-in.

Pricing Flexibility

- Most Cloud providers allow customers to pay only for the services and storage they need on a flexible timeframe, meaning that customers can scale up their services step-by-step, avoiding the risk of an all-at-once transition.
- Cloud providers operate on a monthly billing cycle regardless of contracts and offers pay-as-you-go pricing so that customers can migrate their services without a loss.

Easy Migration

- Switching to another on-premises datacenter software provider is often expensive and slow due to the need to self-configure hundreds or thousands of servers in-house. Migrating to Cloud providers makes the process faster and safer with services like [Redacted].
- Most Cloud providers have in-house teams ([Redacted] Migration, IBM Garage Cloud Method), and third-party services (Cloudendure, Attuinity) to move data to the Cloud, from a variety of formats (Oracle, Windows, etc.).

Software Compatibility

- Most public Cloud providers are compatible with many private Cloud configurations, meaning that customers have more options for configuring their Cloud. The hybrid Cloud is a viable strategy for many customers.
- Cloud providers also make it easy to switch between public Cloud services (e.g. from [Redacted]).

Key Takeaway

Switching to the public Cloud mitigates many of the fears surrounding vendor lock-in due to its flexibility, ease of migration, and general compatibility.

[Redacted], [Redacted], Azure

Alleviating Vendor Lock-In

Because enterprises may have specific data formatting needs and/or be wary of shifting solely to one provider, most Cloud companies offer hybrid and multi-Cloud options.

Data Formatting and Migration

Some companies may have particular data formatting and filtering. Communicating these changes may seem difficult. However, all Cloud providers have third parties that help with data integration, like Informatica.

Multi-Cloud Strategy

If data requires rigorous formatting and customization, it is possible to reap some of the benefits of the Cloud by migrating each part of an enterprise to different Cloud providers. When pursuing this strategy, most companies will opt to choose a primary Cloud provider that handles 80%+ of their workloads.

Hybrid Cloud Strategy

If data is so rigorously formatted that no Cloud provider can fit the niche, enterprises can *still* reap the benefits of the Cloud by **migrating the "easier" parts of the business** to a Cloud service, and keeping the rest on-premises.

Key Takeaway

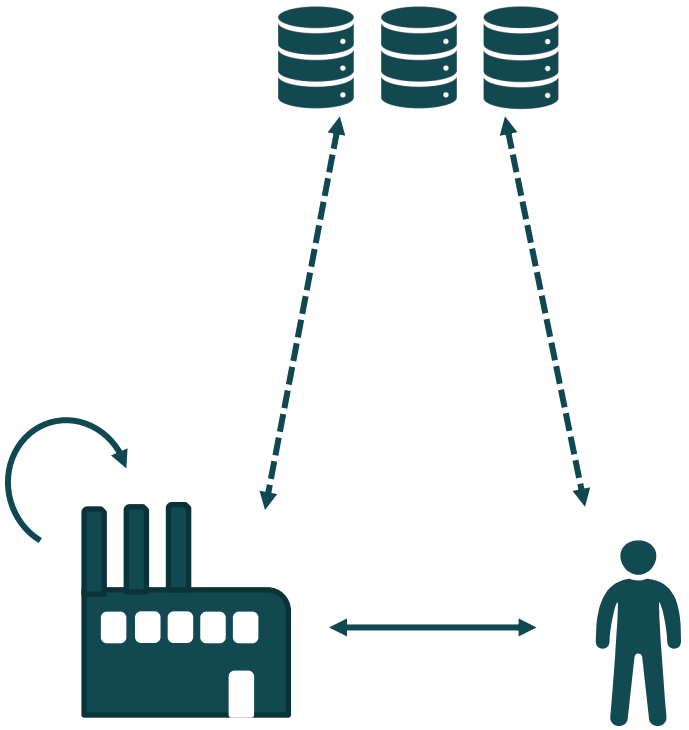
In general, there are ways to reduce or eliminate vendor lock-in concerns, given that most large Cloud providers have hybrid and multi-Cloud options.

Gartner

Longer Distance Means Higher Latency

Some potential enterprise customers avoid migrating to the Cloud because they worry latency is inherent to the public Cloud.

- Information can only travel as fast as the speed of light, so having data stored at a greater distance from companies and customers can cause delays in data processing
- The public Cloud stores data in off-site data centers so some companies are worried this data latency is inherent to the public Cloud
- Slower data delivery and processing can impede a company's daily operations and cost the company a competitive edge in speed-based marketplaces

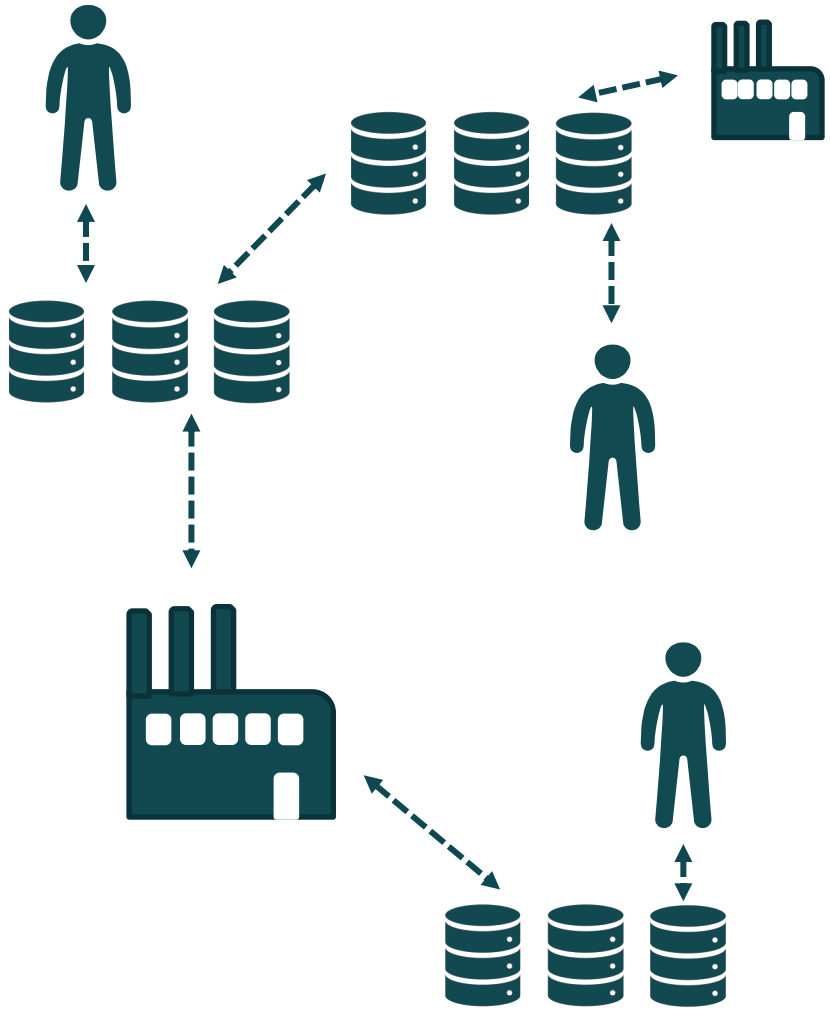


IDG ClearSky Data City Cloud, Interview with [Redacted] Data Engineer

Cloud Actually Decreases Data Latency

Services like [Redacted] reroute data processing to the closest possible data center, decreasing distance data travels, and therefore data latency.

- Public Cloud can **pre-emptively reroute data processing** to the data center nearest to an individual customer or regional company office
- This rerouting minimizes the distance data has to travel, decreasing data latency
- In an increasingly widespread global marketplace, the public Cloud can **decrease data latency** at a scale physically unachievable by most on-prem data storage and processing programs



Data pathways with Cloud

[Redacted], Channel Futures , Interview with [Redacted] Digital Engineer

[Redacted] Group's Transition to [Redacted]

Expedia migrated from on-prem to [Redacted] after internal metrics showed error pages—caused by data latency—were the biggest reason customers abandoned searches.

2010

[Redacted] chooses to partner with [Redacted] because [Redacted]'s global distribution of data centers will greatly decrease customer data latency: "There was **no way for us to solve this problem without [Redacted]**." (Technology Director Murali Gopalan, 2015)

2011

[Redacted] uses [Redacted] partnership to make AirAsiaGo partnership with Asian Airlines possible. Data latency is reduced to competitive levels by rerouting to data through [Redacted] data centers in Southeast Asia.

Pre-2010

Data for all [Redacted] platforms is stored in Chandler, AZ (on-prem). Internal metrics at Expedia show the biggest reason customers abandon searches is an error page caused by data latency

2010-2011

Data latency decreases enable [Redacted]'s launch of [Redacted] Suggest Service (ESS).

Present

[Redacted] continues to grow partnership with [Redacted]. "Latency was our biggest issue. Using [Redacted], **we decreased average network latency from 700 milliseconds to less than 50 milliseconds**." (Principal Architect Magesh Chandramouli, 2015)

[Redacted]

Data Sovereignty and Compliance

Enterprises face stringent regulation over where/how their data *must* be stored. Most Cloud providers have services to address these regulations.

1 Understand regulations for a specific geographic region

- Data regulations differ by government, industry, and type of data
- Common requirements: all data of a certain type stored within country's borders (e.g. France, US Federal), personally identifiable data requires explicit permission to be shared (e.g. health information)

2 Ensure Cloud partner is capable of meeting these requirements

- Physical data centers often have to be built within a country's jurisdiction
- Most leading Cloud providers have met these requirements by building more data centers abroad and partnering with data centers in other countries
- Enterprises should verify the claims of their Cloud providers to ensure that compliance will not be an issue

3 Ask Cloud provider for full transparency of data movement and access

- Enterprise clients want to be able to answer the question: where is my data right at this moment?
- Most Cloud providers have services that provide this feature (e.g. [Redacted] Cloudtrail)

4 Ask Cloud provider to take liability for compliance infractions

- Enterprises should ask Cloud providers to take full liability for following data sovereignty regulations
- These clauses can be spelled out explicitly within contracts to avoid compliance problems

NASCIO , [Redacted] , SG Analytics, Berkman Klein Center

Trends in Cloud Regulations

Regulating the Cloud is a relatively new policy question. There are no global standards on what Cloud regulations should look like.

Privacy

- Sectorial (US): heavily regulates finance, health, and education industries. Few or none regulations on other industries.
- Total (Europe): regulates all data in the Cloud (new law, GDPR)

Formality

- Explicit (US, Europe, Japan): Regulations explicitly stated and enforced by courts (some edge cases)
- Implicit (China, Russia): Direct government involvement with enterprises, "assumed" regulation

Responsibility

- Up the stack means more enterprise responsibility for compliance
- Down the stack means more Cloud provider responsibility for compliance

Locality

- US: few locality regulations, main Cloud providers already based in country
- Europe: many locality l[Redacted], few Cloud providers based in country
- China, Russia: many locality l[Redacted], need to be able to access individual and enterprise data at any point without jurisdiction red tape

Interview with Harvard Faculty

Benefits of Switching to Cloud Services

There is a vast array of benefits that accompany migrating IT services to the Cloud. In this section, we explore some of the most significant benefits, as well as analyze some case studies.

Benefits of Migrating to the Cloud

Cost Savings | Privacy and Cybersecurity | Improved Management

Development Costs	▪ Cloud service providers replace the need for companies to develop costly and time consuming solutions for problems easily solved by migrating to the Cloud ▪ **Case:** Alstom switches to the Cloud and reduces its original IT services costs by 90% .
Efficiency Gains	• The Cloud allows companies to easily set up environments for multiple projects at once that run smoothly and efficiently and the implementation of existing services and structures into their products. • During high-volume periods, the Cloud enables companies to be more responsive to customer needs. • **Case:** Switching to the Cloud allows Alstom to spin up to 100 virtual machines in a morning, which increases productivity and overall gains
Migration Costs	• In many cases, migration timelines have been cut short by the innate power of the Cloud, so the company is able to recover quickly, if not immediately, for the gap in productivity that comes with migrating systems. • **Case**: American Airlines' migration time to the Cloud was cut short, saving AA money that would have been associated with this migration period as services are temporarily unavailable as the transition occurs.
Cyberattack Losses	• Cyberattacks not only hinder the integrity of a company, but they also pose severe costs. However, the Cloud can help prevent many cyberattacks because its data is stored in a way less vulnerable to outside attacks. • The Cloud also is continually improving its response to attacks on development and IT infrastructure. • **Case**: Alert Logic's transition to [Redacted] has allowed it to focus on its SaaS business and not worry about potential revenue or productivity losses due to cyberattacks

Wired Magazine

Benefits of Migrating to the Cloud

Cost Savings | **Privacy and Cybersecurity** | Improved Management

Cybersecurity	▪ Cybersecurity inherently reduces the physical security risks posed by traditional on-premise data centers. Large Cloud service providers have invested lots of money into cybersecurity, at a scale generally unattainable by most companies. ▪ **Case:** Maersk uses Cloud services to move five physical datacenters to the Cloud.
Sensitive Data	• Clients dealing with sensitive data find the Cloud to be a more secure and encrypted form of data storage. Not only that, but network security and access control allow for a company to adjust the security of their data. • **Case:** [Redacted] finds [Redacted]'s multiple and automatic backups capabilities useful in managing their sensitive financial data in a more secure and efficient manner than traditional methods.
Cyberattack Prevention	• Prevention of cyberattacks is made possible by the Cloud because storing data in the Cloud renders the data less vulnerable to outside attacks and helps enterprises quickly reestablish themselves after. • Looking to a Cloud computing providers can be more useful for cyberattack prevention over in-house solutions because of their already-established security measures. • **Case:** Maersk has not been harmed by a cyberattack since migrating to the Cloud.
Privacy	• While privacy is a large concern for many legacy customers, encryption, data access control, where data is stored geographically, and subpoenas for data disclosure are some of the many ways the Cloud actively acts to minimize this risk. • **Case:** The CIA hosts data on [Redacted], and the CIA CIO calls it "the best decisions [we] have ever made."

Wired Magazine, *CNBC*, *Federal Computer Weekly*

Benefits of Migrating to the Cloud

Cost Savings | Privacy and Cybersecurity | **Improved Management**

Supply Chain	▪ Moving various levels of a company to the Cloud allows for increased connectivity and productive connections ▪ The Cloud also allows for more efficient and immediate scaling ▪ **Case:** GE Oil and Gas's transition to the Cloud occurred on a similar timeline to other GE departments which enabled Gas and Oil to take advantage of templates and products from those other departments.
Internal Management	• The Cloud's ease of access improves the cohesiveness of a company as a whole that enables, especially large, enterprises to manage in a consistent and effective manner. • **Case:** Alstom's global cooperation was increased due to migrating to the Cloud, as the Cloud facilitated better communication throughout Alstom's far-reaching network
Developer Productivity	• The Cloud offers capabilities and AI tools that are not necessarily within reach or practical, both financially and/or technically, for many companies to develop internally. Outsourcing infrastructure enables internal developers to focus their work while also reducing costs. Fewer hours are then spent on data analytics, maintenance, etc. • **Case:** AFG transitioned to [Redacted] services and saved so much money that they expanded their developer team by 68%
Customization	• The Cloud enables customized solutions for clients and customized solutions for clients to offer to their customer base. [Redacted]'s Internet of Things (IoT) services integrate artificial intelligence into its products allowing for more customizability. • **Case:** [Redacted] used Cloud-based technology to personalize the banking experience with a customizable mobile app and managing individual spending and account data.

Wired

Cloud Transition Case Studies

[Redacted]

Case I: The Weather Company

The Weather Company is a weather forecasting and information technology company. As of 2015, it is a subsidiary of the Watson & Cloud Platform business unit of IBM.

- The Weather Company is the parent company for The Weather Channel and other radio and television broadcast channels, as well as digital properties such as weather.com
- Applications for broadband and mobile platforms like IOS and Android
- Applications in industries and sectors such as aviation, broadcasting, energy, insurance, and government
- Provides weather forecasts for 2.4 billion locations worldwide and has a global grid of 37 million four-kilometer squares
- Had 13 data centers running legacy systems built and run on Fortran

> "Our users and clients turn to us to help them make weather-related decisions with confidence. This study shows The Weather Company as the undisputed accuracy leader, confirming the trust of more than 250 million people who choose The Weather Company for weather information every month."
>
> - Mary Glackin, Senior Vice President of Science and Forecasting operations, The Weather Company

- TWC is moving to a multi-vendor Cloud architecture
- TWC migrated all of its B2B Cloud and on-premises application load from [Redacted] and their 13 data centers located in the US to IBM Softlayer in 2015
- The Weather Company began balancing their consumer and B2B API workload across IBM and [Redacted] environments later in 2015, with the long term goal of shifting more of its API workloads to IBM

High Latency	TWC wanted a Cloud provider with the global reach that could help them their services be accessible to everyone on the planet.
Scalability	As a company that generated four terabytes of data every hour, TWC needed a cloud provider that could accommodate their high volumes of data.
Slow Innovation	Developing and launching new systems internally took too much time, money, and effort.
News	In 2015, IBM acquired the Weather Company's business-to-business, mobile and cloud-based web properties, but TWC still uses [Redacted] for its consumer business.

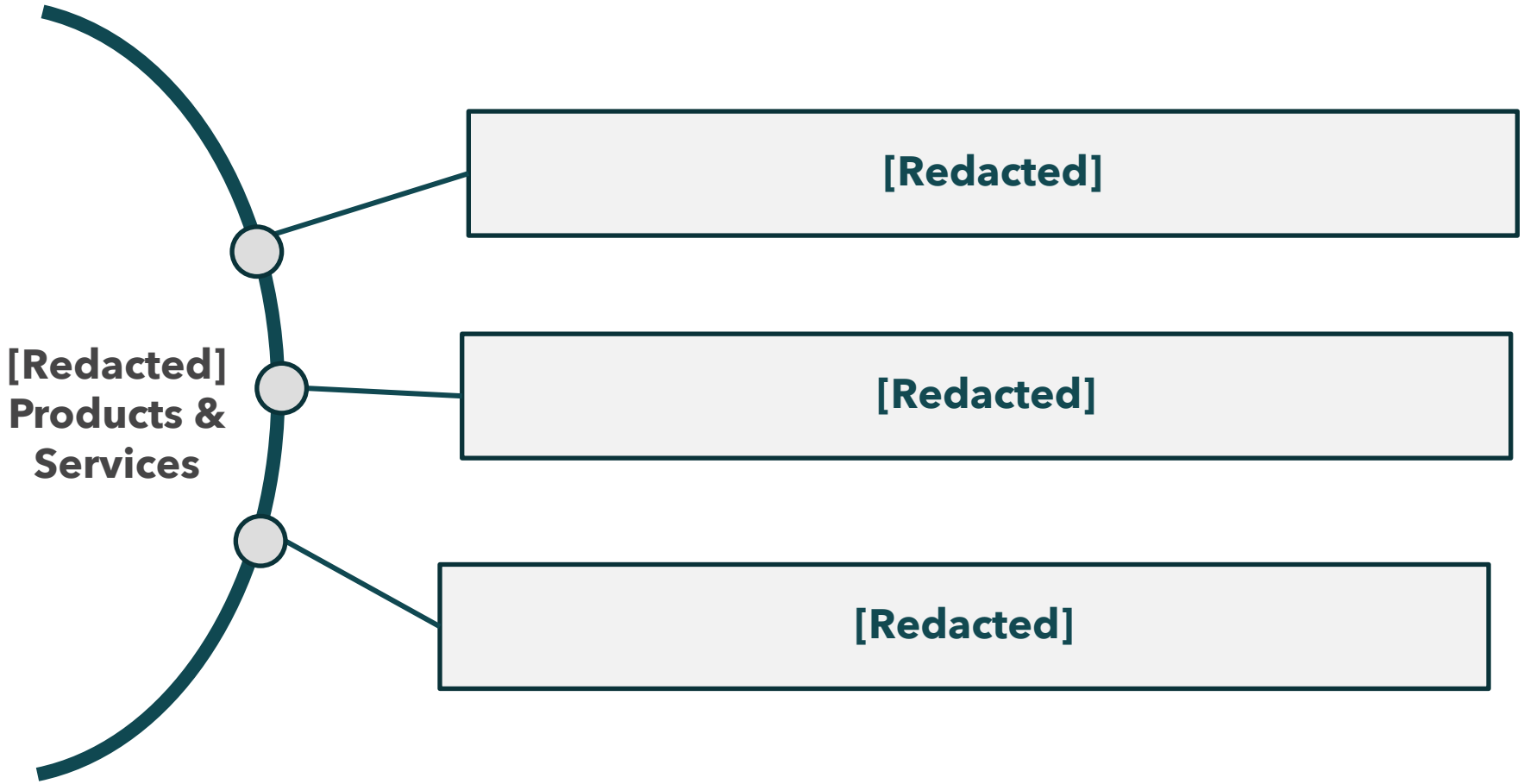
Key Takeaway

TWC ultimately chose to migrate to the cloud because their data infrastructure was not cost-effective or scalable.

IBM, IBM Press Release 2017, eWeek 2017

[Redacted] Offerings Used By TWC

The Weather Company leveraged [Redacted] to migrate their Java-based monolith infrastructure and build a more accurate on-demand forecast system.



InformationWeek

How [Redacted] Addressed TWC's Needs

[Redacted]'s Cloud solution helped TWC divert resources away from maintaining their outdated data centers and toward innovation; IBM SoftLayer gave TWC a global reach.

1 Lower Latency

TWC consolidated its 13 data centers to 4 and moved toward a multi-Cloud strategy that allowed them to improve their global data center presence and network business model

IBM's networking capabilities helped TWC handle big data and incorporate the Internet of Things into their applications

2 Scalability

[Redacted] helped TWC re-design its big data platform, forecasting systems, and applications to run natively in a Cloud environment

Data stored on [Redacted] instead of their on-prem storage, eliminating the hassle of managing a storage platform

3 Faster Innovation

[Redacted] APIs to automate application development and the launch of new environments

Cloud platforms that APIs are run on are robust enough to handle more transactions

4 Advanced Data Analytics

Improved data handling with [Redacted], which provides analytical data for services such as the WeatherFX ad engine

IBM licensed its Cloud-based data platform and collaborated with TWC's B2B division to deliver joint solutions tailored to specific industries

[Redacted], *TechTarget*

Industry Expert Commentary

Migrating workloads to [Redacted] and IBM SoftLayer gives TWC unprecedented flexibility and agility.

John Kelly
Senior VP, IBM Solutions Porfolio and Research

The Weather Company's **extremely high-volume data platform**, coupled with IBM's global Cloud and the advanced cognitive computing capabilities of Watson, will be **unsurpassed in the Internet of Things**, providing our clients **significant competitive advantage** as they link their business and sensor data with weather and other pertinent information in real time.

Bryson Koehler
TWC Executive Vice President and CIO

Building and designing for the Cloud is a different philosophy and mind set, and certainly a different technical approach […] We deploy about **90 percent of our applications and systems on [Redacted]** – and we have the **flexibility to easily port applications and systems** as necessary for the business.

Bryson Koehler
TWC Executive Vice President and CIO

The less my engineers have to worry about power, cooling, racking, stacking, and other operations tasks, the more they can focus on the business […] They can focus on being application engineers, building resiliency into the apps, and improving network and application efficiencies.

[Redacted]

Case II: [Redacted]

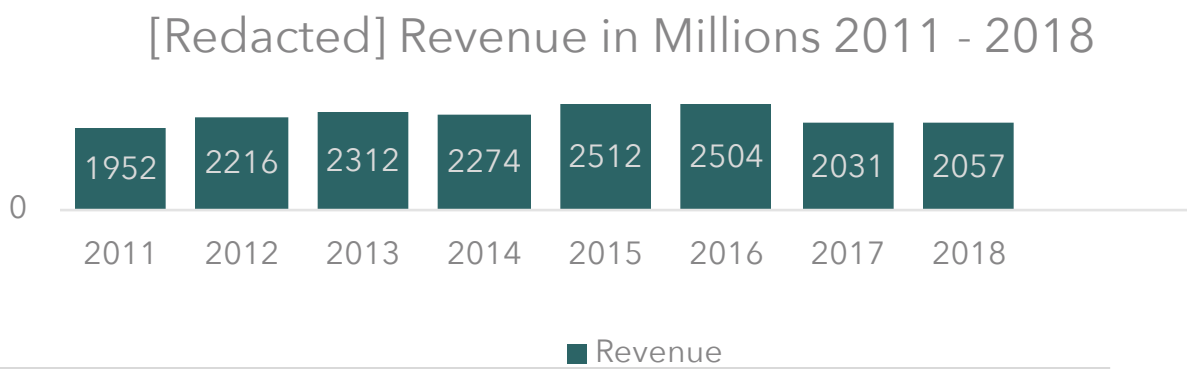
[Redacted] founded the computer-aid design market and has continued to work on simulations in various fields, recently partnering with [Redacted].

[Redacted]

- [Redacted] creates software products for architecture, engineering, construction, manufacturing, media, and entertainment industries
- Primary product is [Redacted], a computer-aid design and drafting application, which was created in 1982 and spear-headed the market
  - Various variants on the version including [Redacted], a program mainly used by civil engineers
- [Redacted] also has products such as [Redacted] which are used in movie production fields and animation

> "Autodesk makes tools for people who make things. It's our customers who build all the buildings in the world, the smartphones you use, the bridges you drive over, and even the entertainment you watch."
>
> - Brian Matthews, [Redacted]

Statista



Internal Organization

[Redacted] is based in San Rafael and is led by a team of executives with CEO Anagnost. The company has 15 different departments, including informational technology and user experience.

Consumer Base

[Redacted] operates internationally and serves a wide variety of consumers, from motorcycle-production companies like Lightning Motorcycle to water sanitation companies like Splash.

Market Position

[Redacted]'s revenue in 2018 was about 2 billion dollars. In 2016, their revenue share was 29% for the computer-aided design market. In terms of market share, they are a market leader in CAD.

Recent News

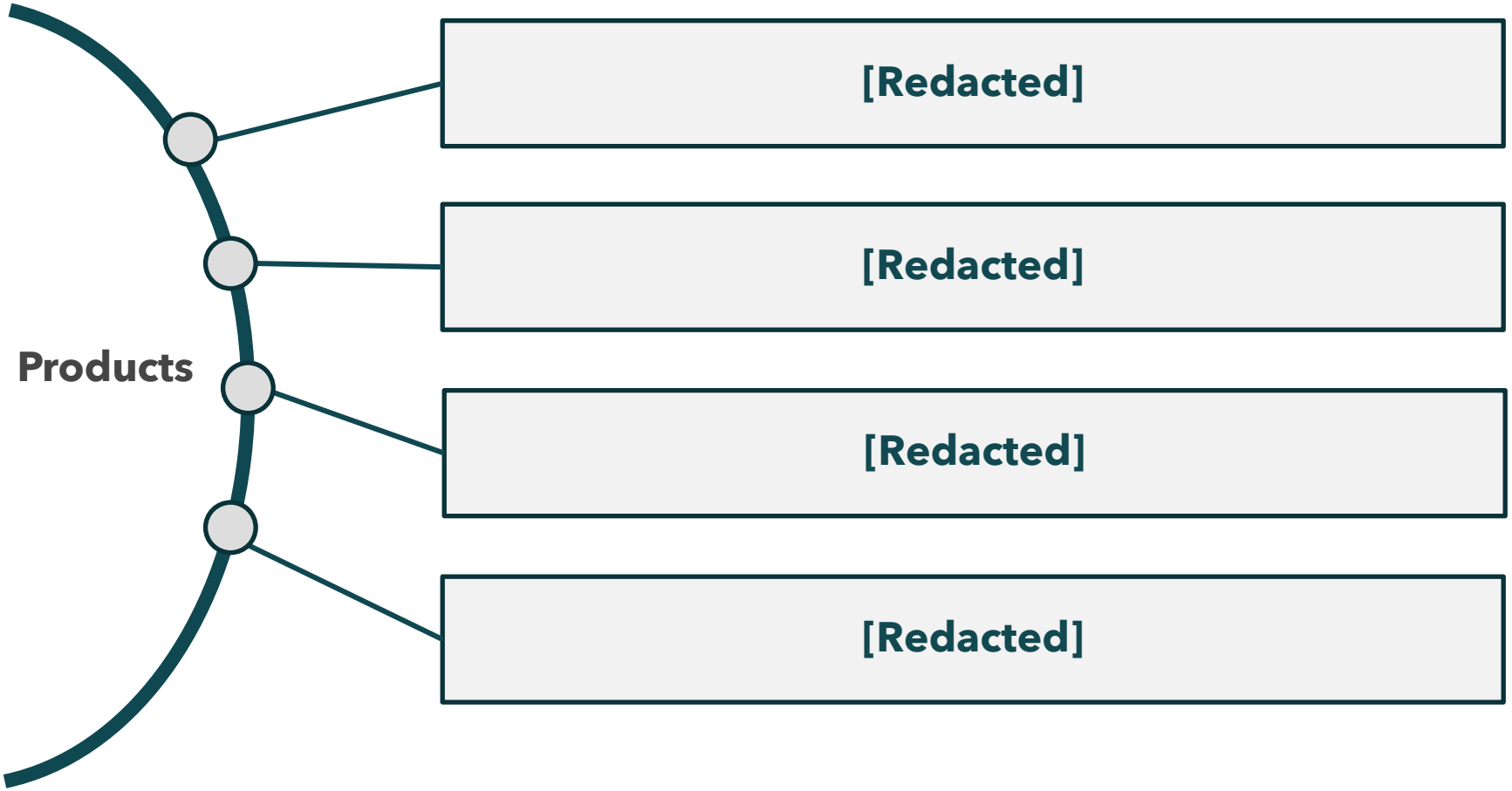
[Redacted] is focusing on how the Cloud and machine learning can impact generative design for a wide-range of industries.

Key Takeaway

[Redacted] created the market for computer-aided design and is utilizing generative design to optimize the design of simulations.

[Redacted] Offerings Used By [Redacted]

[Redacted]'s focus on generative design requires fast and efficient scalability of computational ability along with storage of large amounts of data.



[Redacted]

How [Redacted] Has Leveraged [Redacted]

[Redacted]'s partnership with [Redacted] allows the company to run hundreds of simulations at a time creating efficient generative design in [Redacted]'s CAD programs.

Lightning Motorcycle

- Largest producer of electric and speed-optimized motorcycle
- Wanted to make swing arm lighter
- [Redacted] simulation using specific weight, material, and cost constraints used [Redacted] scalable computing to accomplish generative design
- New part was both stronger and lighter

Airbus

- Needed to optimize bulk weight to a goal of about 5% weight reduction
- Data storage combined with multiple virtual machines made for "synthetic evolution"
- Accomplished stronger material at **45% weight reduction**
- Fuel savings were equivalent to 96,000 less cars on the road

Office Building

- [Redacted] forecasts building need is exponentially increasing but construction wastes are about 30%
- Architects cannot account for subjective preferences
- Computer takes advantage of survey data along with material and costs to create architectural options in the thousands

[Redacted]

[Redacted] Expert Commentary

[Redacted] employees find that [Redacted] services not only allow their products to be cutting-edge on the CAD market, but also give them more time to devote to R&D.

Brian Matthews
VP of Platform Engineering

[Redacted] has allowed us to focus on simulation and generative design rather than managing storage and database. [Redacted] has continuously upping their game way as well, bringing down the cost of computing and bringing the horsepower we need for this new future.

Josef Waltl
Global Segment Lead

The power of the Cloud is a key enabler to bring generative design technology to designers and engineers in a fast and cost-effective way. With close collaboration between [Redacted] and [Redacted], customers will be enabled to design and produce highly innovative products which outpace existing design in economic and environmental dimensions.

Brian Matthews
VP of Platform Engineering

The Cloud has produced something beyond organic. It's like playing evolution forward a **few million years in an afternoon.**

[Redacted]

Case III: [Redacted]

[Redacted]'s rapid growth and fast-moving technology needs necessitate a flexible and scalable Cloud computing infrastructure.

"Initially, the appeal of [Redacted] was the ease of managing and customizing the stack. It was great to be able to ramp up more servers without having to contact anyone and without having minimum usage commitments. As our company continued to grow, so did our reliance on the [Redacted] Cloud and now, we've adopted almost all of the features [Redacted] provides. [Redacted] is the easy answer for any Internet business that wants to scale to the next level."

Nate Blecharczyk, Founder and Chief Strategy Officer, [Redacted] (former CTO)

[Redacted], *Forbes*

- [Redacted] is a fast-growing hospitality and technology company that matches guests with hosts looking to rent out their homes and apartments.
- [Redacted] was founded in 2008, and began to move its computing functionality and databases to the Cloud in 2009. [Redacted]'s technical infrastructure is highly integrated with [Redacted], allowing [Redacted] to efficiently scale its data usage and take advantage of [Redacted]'s numerous features.

Hosts	[Redacted] has over five million listings worldwide, where hosts can rent out their homes for short-term stays.
Guests	[Redacted] has had over 400 million guest stays all-time with 2 million nightly stays per night, on average. Demand varies greatly, with peaks during holidays and different times a year.
Experiences	[Redacted] offers over 15,000 Experiences, or curated tours, trips, and other guided activities to supplement stays in cities around the world.
Growth	[Redacted] is currently valued at roughly $38 billion after a decade of growth. Over 191 countries have [Redacted] listings, highlighting its global reach.

Key Takeaway

[Redacted]'s Cloud computing capabilities and ability to elastically scale up and down resources are critical to managing the data and traffic that [Redacted] handles daily.

Why [Redacted] Chose [Redacted]

[Redacted] began moving its core Cloud functionalities onto [Redacted] in 2009, a year after the company launched.

Low Operations Cost	▪ [Redacted] has very few costs and teams associated with in-house database management due to [Redacted]. Engineering teams can focus on new development rather than operations. ▪ "We concentrate more of our energy to solving problems unique to [Redacted]," Mike Curtis, [Redacted] VP of Engineering
Intelligent Computing	▪ Machine learning applied to search ranking and fraud detection helps [Redacted]'s core product functionality and builds trust – matching legitimate hosts to reputable guests.
Faster Development	▪ [Redacted] saved time building a database key management application by utilizing [Redacted] service, accelerating engineering teams by 6 months. ▪ Instead of building in-house database redundancy and failover software, [Redacted] relies on [Redacted] deployments for failover.
Flexibility	▪ [Redacted] is particularly useful when running workloads that rapidly scale up and down. ▪ [Redacted]'s traffic is highly variable; the number of customers booking rentals peaks around holidays, for example. It can take advantage of [Redacted]'s scalability to use resources only when necessary.

CIO, [Redacted]

[Redacted] Offerings Used By [Redacted]

[Redacted] moved all of its core information and Cloud computing to [Redacted], utilizing a wide array of compute features.

[Redacted]

- [Redacted] uses 200 [Redacted] instances for running and managing its application, memory cache, and search servers.
- [Redacted] uses [Redacted] to distribute and balance traffic over its [Redacted] instances.
- [Redacted] is the core of [Redacted]'s computing infrastructure, powering its **search, fraud detection, and ML applications.**

[Redacted]

- [Redacted] uses [Redacted] for data storage, including many terabytes of image storage and backups.
- [Redacted] Elastic MapReduce helps [Redacted] parse large amounts of incoming data, compute on it, and generate actionable results.

[Redacted]

- [Redacted] moved its primary MySQL database to [Redacted] to simplify database management tasks, replication, scaling and more through basic API calls or [Redacted] Management console in a time-efficient manner.
- The transition was completed with **only 15 minutes of downtime.**

[Redacted]

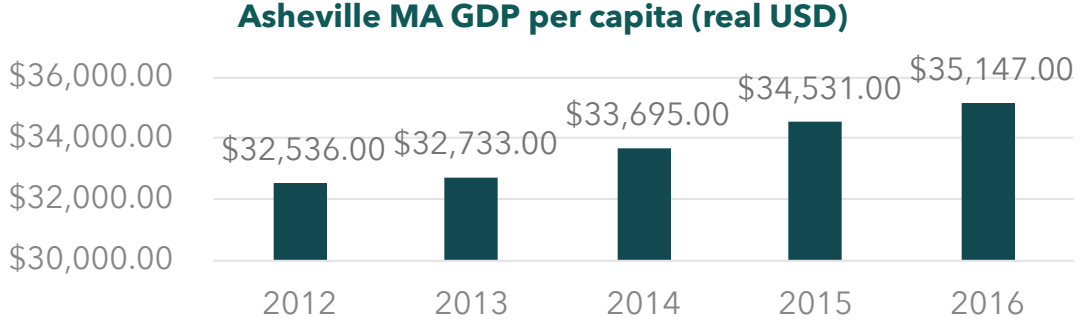
Case IV: City of Asheville

Asheville, NC is a midsized regional hub in the North Carolina mountains. It is one of the first cities to transition data backups to the Cloud.

Asheville, NC

- Population at night: 85,000
- Population during the day: 120,000
- Blueridge Mountains
- Risks: Hurricanes, Flooding, Landslides, Water/gas/sewer pipes bursting

> "Mountain-ringed and progressively minded, the city that calls itself Land of the Sky is renowned for its creative spirit"
>
> Jeremy Egner, New York Times



UNC-Asheville	Only dedicated liberal arts college in University of North Carolina system. 3900 undergraduate students, 330 full- and part-time faculty. Two thirds of students live within a mile radius of campus.
Biltmore Estate	8000 acre estate built in late 19th century by Vanderbilt family. Was largest private residence in the US. Now tourist destination with winery, restaurants, and estate tours. More than 1 million visitors/year.
Arts	Experimental arts scene includes pottery, folk art, paintings, sculpture, theater, and cinema. Site of filming of "Hunger Games" movies. Arts district downtown includes galleries and multiple museums.
Outdoor Activities	Blue Ridge Mountains and French Broad River offer opportunity to hike, mountain bike, ski, white water kayak, raft, zipline, and fish. 26 outdoor gear manufacturers based in Western NC.

Key Takeaway

Asheville attracts many visitors for its pristine natural beauty, but also faces pressure to reduce costs and create better disaster response readiness programs because of its location in the middle of a mountain range.

US Bureau of Economic Analysis, New York Times, [Redacted], UNC-Asheville, Biltmore, National Geographic, CitizenTimes, Interview with Asheville government official

Asheville's Transition To The Cloud

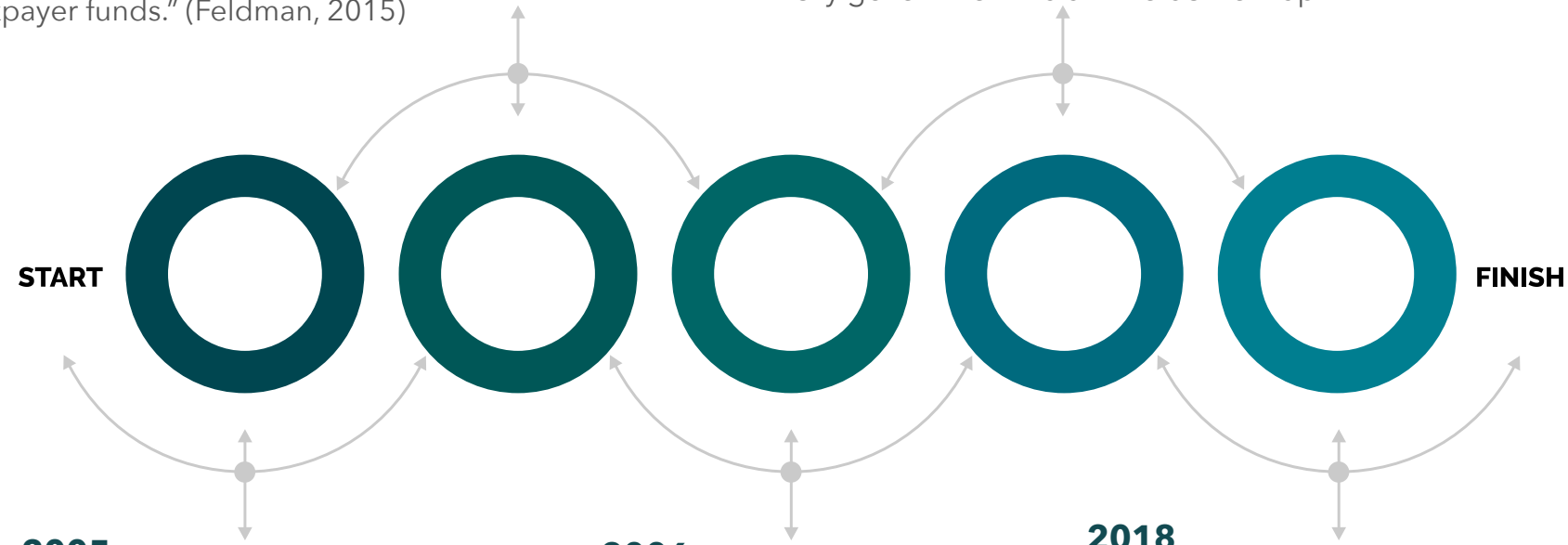
CIO Jonathon Feldman switched Asheville to the cloud to make the city's disaster recovery systems more resilient.

2005

Asheville looks into building stand-alone city data center. There is no suitable location that would avoid natural disasters. Building a data center would also be expensive to taxpayers: "it's a terrible use of taxpayer funds." (Feldman, 2015)

2007-2015

Asheville uses [Redacted] cloud to expand city services, i.e. The Asheville App which enables citizens to report problems that need to be addressed by the city government via an interactive map



2005

Jonathon Feldman becomes CIO of Asheville. He recognizes disaster response systems are too geographically close to be effective.

2006

Asheville partners with start up CloudVelox to move DR data to [Redacted]'s cloud, one workload at a time.

2018

Asheville continues partnership with [Redacted], wins [Redacted]'s "City in a Cloud" award for new project creating cloud database to help minority small-business owners access town resources

[Redacted], *Next City*, *Interview with Asheville government official*

Reasons Asheville Switched to The Cloud

Asheville needed a cost-effective data storage system that would be resilient in utility emergencies and natural disasters.

Resiliency	"We've solved a bunch of problems for disaster recovery by starting to use [Redacted] because its very important to have geographic diversity with disaster recovery." Many natural and utility disasters have devastating local consequences, so Asheville's recovery systems needed to be based in a geographically different space.
Security	"For small municipalities there's no way you have a security team the size of [Redacted]'s or as effective as [Redacted]'s" Much of the data that needed to be backed up for effective disaster response is sensitive city government data. The cloud offered the best security options for protecting this data.
Reduced Costs	"[Redacted] allowed us to be better stewards of the Asheville's important technology services as well as taxpayer resources" Building a data center would have cost the city close to $1 million. Moving to the cloud enabled Asheville to have off-site recovery systems at a fraction of the cost.
Innovation	"We've been able to do some really neat product launches" Asheville's IT department was overworked and received the worst customer service reviews of all city departments because they were spending so much time on maintenance. The cloud freed up time so they were able to create new interfaces to better connect with citizens.

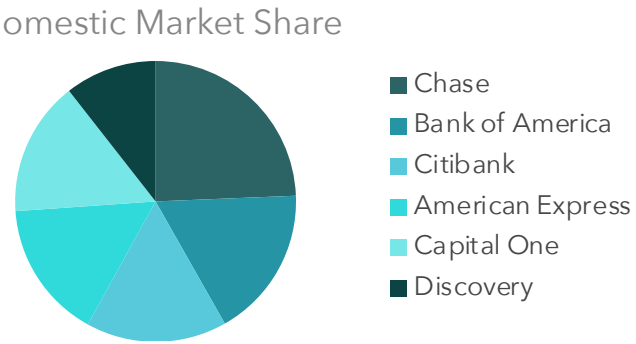
[Redacted] ,Next City, Cloud Velox, Interview with Asheville government official, CXO Talk

Case V: [Redacted]

[Redacted] is a leading financial services company with a market cap of $45.6 billion. It began its transition to [Redacted] in 2013.

- Headquartered in [Redacted], [Redacted] is the 11th largest bank in the United States by assets.
- [Redacted] offers a broad spectrum of financial products and services, including merchant services, [Redacted], and more.
- [Redacted] trades on the New York Stock Exchange and is included in the S&P 100 index.

"The most important benefit of working with [Redacted] is that we don't have to worry about building and operating the infrastructure necessary to do that and can instead focus our time, money, and energy on creating great experiences for our customers."
- George Brady, Executive VP and CTO of [Redacted]



Internal Organization

[Redacted] was founded in 1994 by [Redacted], its current chairman and CEO, and has over 49,000 employees across its many geographic locations.

Consumer Base

[Redacted]'s consumer base includes everyone from individual consumers to small businesses and commercial clients in the US, UK, and Canada

Market Position

[Redacted] 's net income in 2018 Q2 grew by 84.24%, compared to the 31.96% average growth by its competitors.

Recent News

By 2018, [Redacted] hopes to work with [Redacted] to reduce its data center footprint from eight to three.

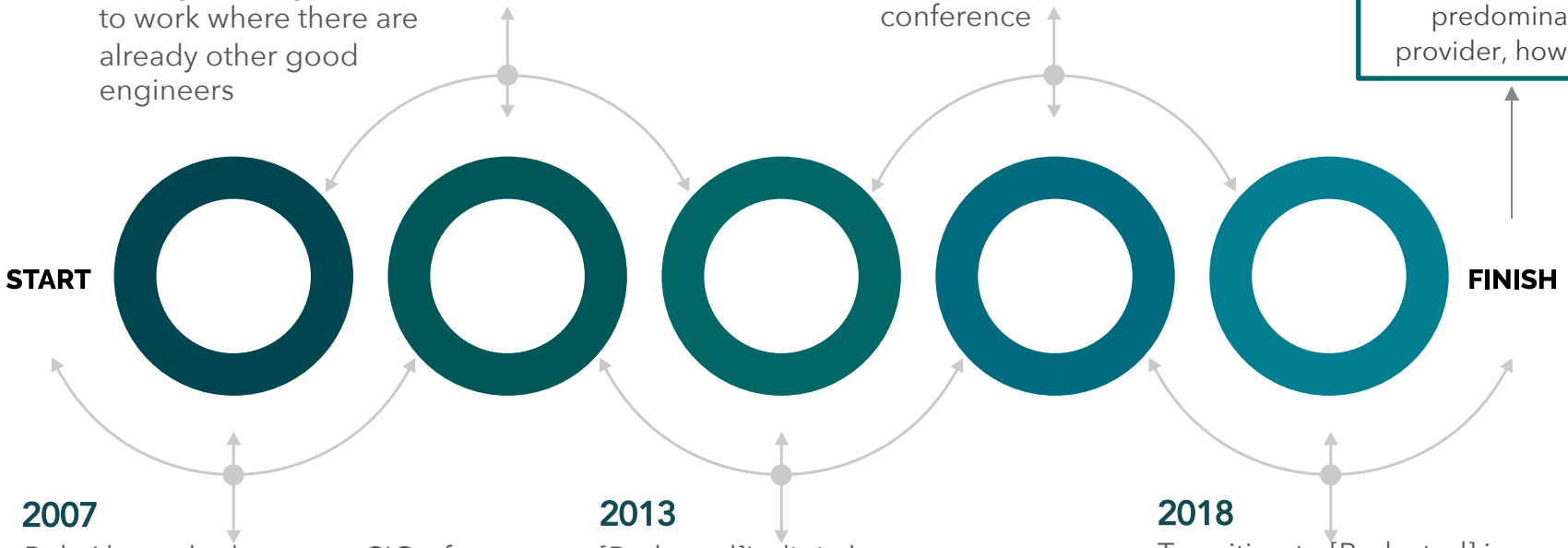
Key Takeaway

[Redacted] is a lead financial services company that believes digital banking is the future, explaining their early switch to [Redacted].

[Redacted]

[Redacted]'s Transition to [Redacted]

[Redacted]'s leaders switched to [Redacted] because they trusted the input of their data engineers. [Redacted] has committed to partnering with [Redacted] through 2022.



2007-2010
[Redacted] has trouble recruiting initial group of digital engineers because most good engineers want to work where there are already other good engineers

2007
Rob Alexander becomes CIO of [Redacted]. He encourages technology focus: "winners in banking are going to be… great technology companies"

2013
[Redacted]'s digital engineers recommend **outsourcing all infrastructure to [Redacted]**

2015
[Redacted] launches mobile banking app with [Redacted] platform, CIO Rob Alexander speaks at [Redacted] conference

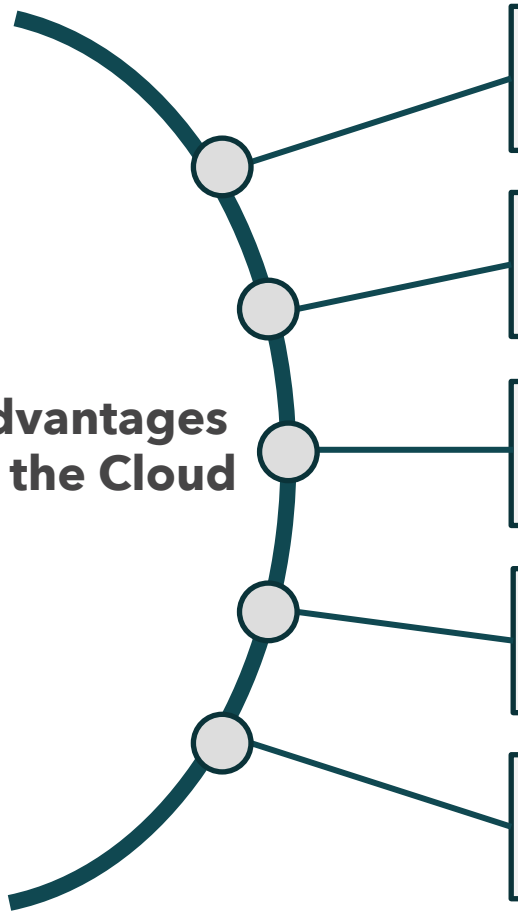
2018
Transition to [Redacted] is still ongoing. [Redacted] has committed to making [Redacted] predominant provider of Cloud software through 2022

Future
[Redacted] is looking to **diversify its Cloud** holders, keeping [Redacted] as the predominant provider, however.

Forbes, Goldman Sachs, Cap Gemini Consulting Report, Interview with [Redacted] Digital Engineer

Reasons to Migrate to The Cloud

Due to [Redacted]'s digital focus, transition to the Cloud was seen as inevitable. Internal dialogue asked "Given we are switching, how is the best way to go about the transition?"



Advantages of the Cloud

REDUCED COSTS
[Redacted] **closed eight resource-heavy data centers** after migrating data to the Cloud.

SCALABILITY
Outsourcing infrastructure enables [Redacted] to easily **scale digital capacity** over the course of the day (e.g. dinner time) and on holidays (e.g. Black Friday)

AUTOMATIC BACK UP
Government regulations require multiple backups of sensitive financial data. Backups can be **automated and stored in multiple locations using the Cloud.**

EFFICIENT DATA ANALYTICS
Data engineers need access to lots of information for short time periods to run trials. Centralizing data in the Cloud makes it easier for them to **access crucial data**

FASTER INNOVATION
[Redacted] engineers can now focus on **innovating banking technology** instead of troubleshooting infrastructure glitches.

Interview with [Redacted] Digital Engineer

Benefits of Cloud Transition

[Redacted] uses Cloud-based technology as a key selling point to both shareholders and customers, and is a major differentiator for them within the market.

Digital banking is the future.

SHAREHOLDERS

- Short term:
  - **Differentiates [Redacted] within industry** because [Redacted] is the first to switch to the Cloud
  - Reduced operations costs because fewer data centers
- Long term:
  - Future of customer interaction with banks
  - Better data analytics mean **continued improvement of services**

CUSTOMERS

- Reduces global carbon footprint
- **Better security** with data in Cloud than in data centers
- Open source philosophy
- Saves time by connecting with other technology (e.g. Alexa, mobile phones)
- **Personalizes banking experience**
  - Individual spending and account data
  - Customizable mobile app

Key Takeaway

Because switching to the Cloud relegates clear benefits to customers, [Redacted] has been able to differentiate themselves within the market, both to shareholders and customers.

Phoenix Corporate, *Seeking Alpha*, *CapGemini*

[Redacted] Offered Smoothest Transition

In 2008, [Redacted] was the only service able to address [Redacted]'s three main concerns: controlling access, staying transparent, and ensuring a streamlined customer experience.

Controlled access	▪ Outsourcing infrastructure risked exposing highly-sensitive financial data to the employees of a third-party Cloud-service provider ▪ [Redacted] was an early leader in **providing checks to ensure sensitive data** would be kept confidential
Transparency for government audits	▪ Government regulations had not caught up with Cloud technology; [Redacted] needed Cloud records to be transparent as defined by regulations designed for data center records ▪ [Redacted] led market in services designed to be regulation compliant
Streamlined customer experience	▪ [Redacted] wanted to make sure customers saw no interruption in banking services ▪ [Redacted] worked with [Redacted] to **transition services to Cloud in parts**: (1) new services (e.g. new mobile app), (2) small internal services, then (3) large, customer-interface services
Bonus: broad range of services	▪ [Redacted] digital engineers were impressed by [Redacted]'s broad range of available services in comparison to Cloud competitors ▪ More services created more flexibility for [Redacted] engineers when innovating new finance tech ideas

Interview with [Redacted] Digital Engineer

How To Migrate To Cloud

After an enterprise decides that it wants to migrate to the Cloud, there are still many steps necessary to implement a Cloud strategy. We outline a few in this section, as well as discuss some precautions that enterprises should take.

Four Steps To Transition To The Cloud

There are significant barriers to any big transition, and migrating to the Cloud is no different. We outline some of the key steps for having a successful transition.

Create a Plan /Implementation Timeline	▪ Consider what **parts of the company** could benefit from the Cloud, what the company culture is, and what timeline the company is looking at ▪ Find a medium between what functions the company wants the Cloud to take on and the functions the Cloud can actually take on (i.e. hybrid, multi, or all-in Cloud models)
Work with Professionals	▪ Hire a consultant/professional IT company to understand how best to transition to the Cloud ▪ Once a provider is chosen, enterprises should **make use of the provider's internal teams**; most Cloud providers give clients dedicated internal teams to help with the migration
Create a Hybrid Solution	▪ Every enterprise has slightly different needs and reasons for migrating to the Cloud ▪ Enterprises should endeavor to create hybrid solutions so as to maintain some consistency and **move slowly rather than quickly** ▪ Organizations can move to the Cloud incrementally, first migrating processes that are ready for transition, and then slowly migrating more processes as they become fit
Migrate More As It Becomes Fit	▪ Having an IT or DevOps team dedicated to reviewing on-prem and Cloud functionality will allow enterprises to transition more processes to the Cloud as the company sees fit and allows the process to be **an on-going and learning experience** ▪ Cloud services are working on security solutions along with other products that may make all current on-prem functions obsolete in the future

Dobson, CIO

Sample Timeline: [Redacted]'s Migration

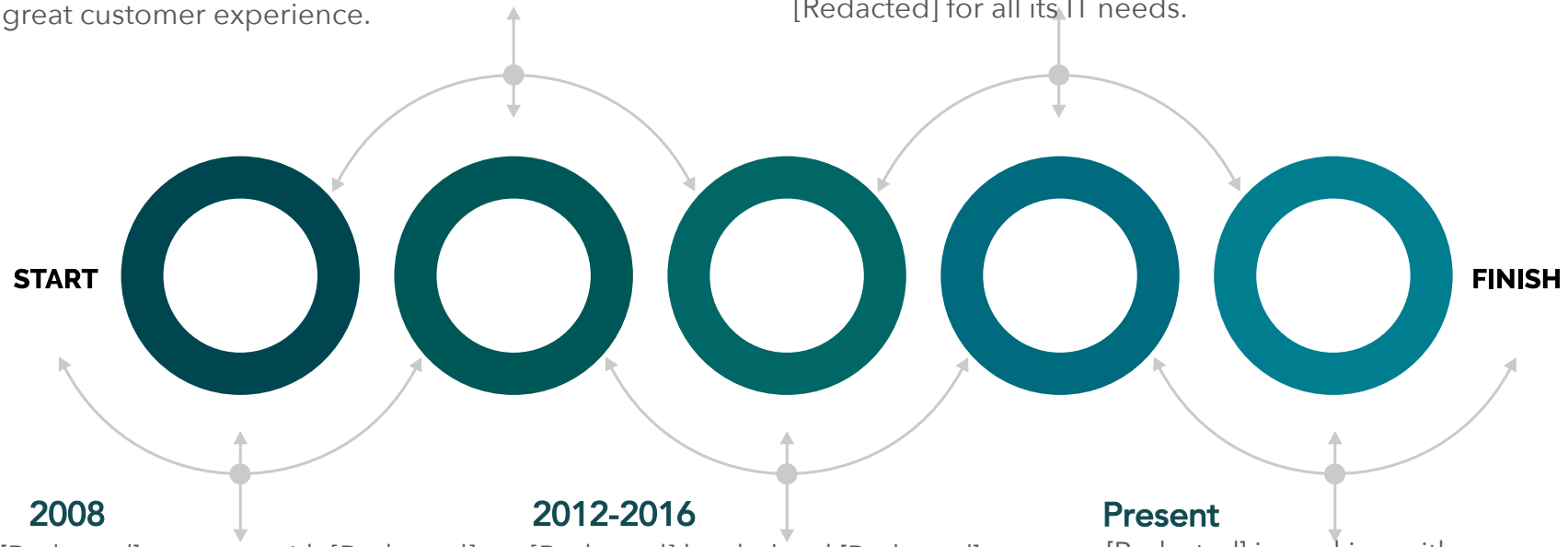
[Redacted] began the migration to [Redacted] in 2008, and continues to use an increasing amount of [Redacted] offerings to provide the best experience possible for ~~its customers.~~

2011

Using [Redacted, [Redacted] is able to better monitor data . "We can discover and respond to issues in real time, ensuring high availability and a great customer experience.

2016

"We unplugged our last datacenter, all done, finished. We don't have a data center anymore, and that's great," – Neil Hunt. [Redacted] has fully migrated to [Redacted] for all its IT needs.



2008

[Redacted] partners with [Redacted] to migrate to the Cloud, and CPO Neil Hunt comments that letting "[Redacted] do the heavy lifting" resonated with the [Redacted] team.

[Redacted], [Redacted] Netflix, Kinesis Streams

2012-2016

[Redacted] has helped [Redacted] achieved "improved productivity, scalability – we've got a much more nimble architecture, and more importantly, [Redacted] pushes the state of the art of new features every year, and we get to take advantage." – Neil Hunt

Present

[Redacted] is working with [Redacted] to increase operation efficiency by using containers and utilizing Blox.

Important Factors in Switching

Like any business decision, it is imperative that enterprises shop around and search for the best provider. One provider may save an enterprise 90%, but another may do better.

Shop Around

Enterprises should endeavor to shop around and **not just choose the first provider** that they find or the one with which they are already in business. Enterprises should look for the best fit, best services, and the best deals.

Analyze All Options

There is significant differentiation within the Cloud market, and analyzing all services, and how they fit in with each enterprise is crucial. Additionally, **analyzing the long-term viability**, cost, and service is more important than choosing the cheapest upfront provider.

Verify Claims

Some Cloud providers have behemoth claims ranging from global reach to best AI. Enterprises should verify claims, if possible, through third party research.

How to Choose the Right Cloud Provider

There are three main Cloud providers in the industry: [Redacted]. We explore these providers, and then explore a few smaller-scale providers ([Redacted]).

Slides 49-67 were Redacted

Key Cloud Benefits

We reiterate ten key benefits enterprises can realize by switching to the Cloud. We hold that these benefits are key to the success of any 21st century enterprise.

Benefits of Cloud

- Development Costs
- Efficiency Gains
- Migration Costs
- Cyberattack Losses
- Sensitive Data
- Cyberattack Prevention
- Privacy
- Supply Chain
- Internal Management
- Developer Productivity